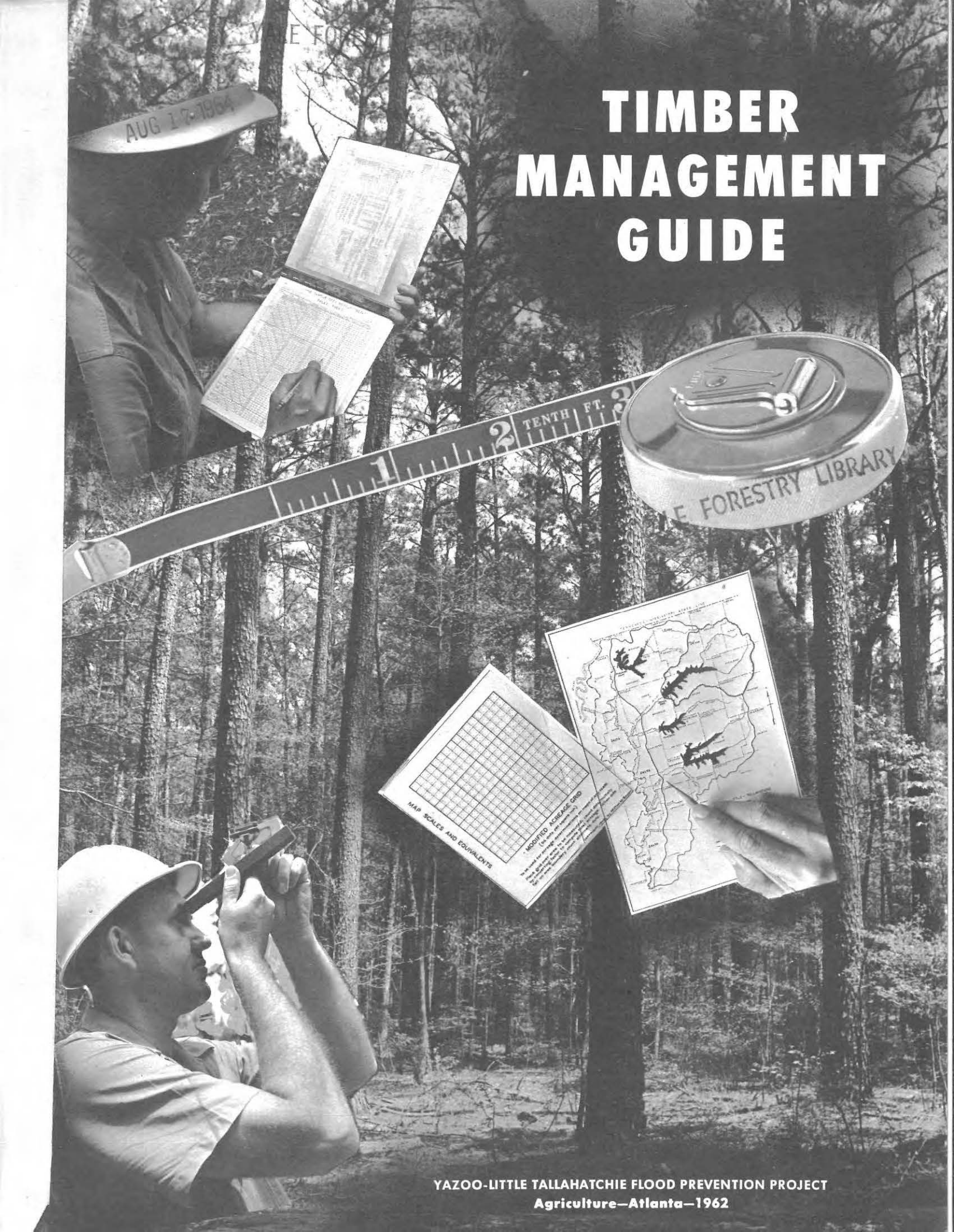
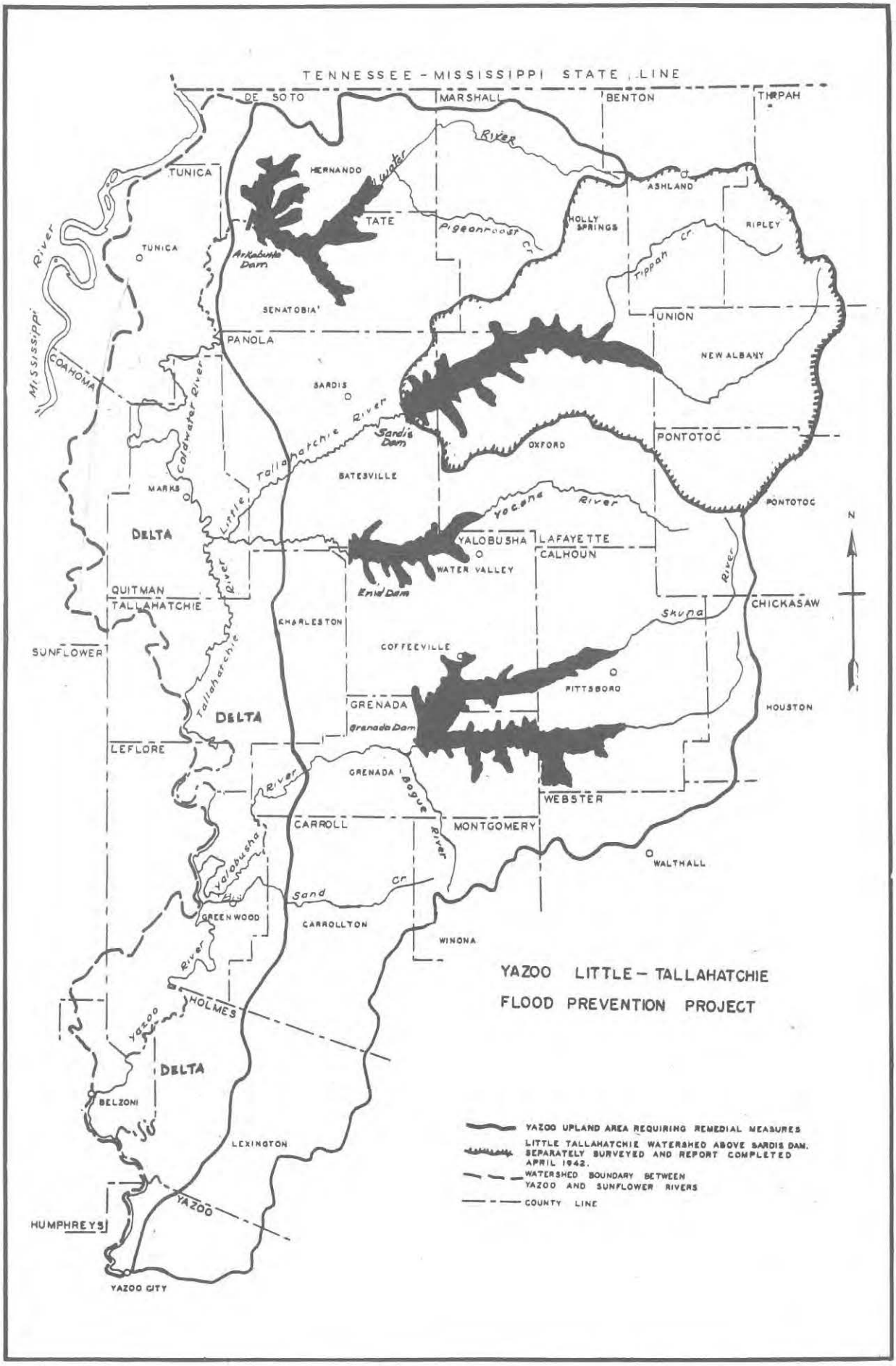


TIMBER MANAGEMENT GUIDE

YAZOO-LITTLE TALLAHATCHIE FLOOD PREVENTION PROJECT

Agriculture—Atlanta—1962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RIPLEY
Tippah Cr.
Pigeonroost Cr.
Arkabutla Dam
SENATOBIA
UNION
PANOLA
NEW ALBANY
COAHOMA
SARDIS
Sardis Dam
OXFORD
PONTOTOC
BATESVILLE
MARKS
DELTA
YALOBUSHA
LAFAYETTE
CALHOUN
WATER VALLEY
Enid Dam
QUITMAN
TALLAHATCHIE
CHICKASAW
CHARLESTON
SUNFLOWER
COFFEEVILLE
PITTSBORO
HOUSTON
GRENADA
Grenada Dam
LEFLORE
WEBSTER
CARROLL
MONTGOMERY
WALTHALL
Yalobusha
Sand Cr.
GREENWOOD
CARROLLTON
WINONA
HOLMES
BELZONI
LEXINGTON
HUMPHREYS
YAZOO CITY
Mississippi River
Coldwater River
Little Tallahatchie River
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Yocona River
Skuna River
Yazoo River
Bogue Phalia River
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YAZOO LITTLE - TALLAHATCHIE
FLOOD PREVENTION PROJECT
YAZOO UPLAND AREA REQUIRING REMEDIAL MEASURES
LITTLE TALLAHATCHIE WATERSHED ABOVE SARDIS DAM. SEPARATELY SURVEYED AND REPORT COMPLETED APRIL 1942.
WATERSHED BOUNDARY BETWEEN YAZOO AND SUNFLOWER RIVERS
COUNTY LINE

TIMBER MANAGEMENT GUIDE

for

YAZOO-LITTLE TALLAHATCHIE FLOOD PREVENTION PROJECT

by

Hamlin L. Williston
Southern Forest Experiment Station

and

Victor B. MacNaughton
U. S. Forest Service

U. S. DEPARTMENT OF AGRICULTURE
U. S. **FOREST SERVICE—SOIL CONSERVATION SERVICE**
cooperating with
SOIL CONSERVATION DISTRICTS

CONTENTS

FOREWORD

This Timber Management Guide has been written to aid project foresters of the Yazoo-Little Tallahatchie Flood Prevention Project in their recommendations for managing forests on highly erosive soils. Compromises with what is considered the best management technique from the standpoint of the forest may have to be made because of an individual landowner's wishes or particular economic situation. The guide assumes that it will be used by a professional forester who will profit by his experience and training to adapt the recommended practices to the individual situation on the ground. Through frequent insertion of new material into the Appendix, the Guide will be updated continually and current recommendations modified in the light of new findings.

Other foresters may wish to use this material but should understand that, while espousing multiple use of the forest, watershed protection is emphasized in this area.

THE PROJECT

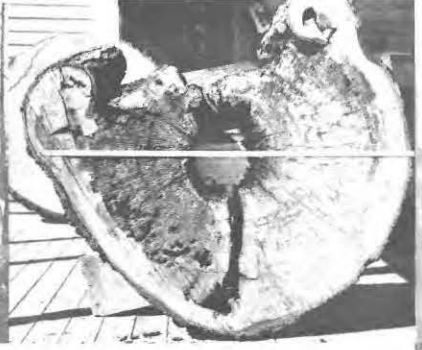
The Yazoo-Little Tallahatchie Flood Prevention Project, hereinafter called the Project, was authorized by Congress in 1944. Working through the Soil Conservation Districts, the Soil Conservation Service and the Forest Service began land treatment in 1947 in the nineteen counties in the Yazoo watershed. The four major objectives of this program are: (1) the reduction of flood water and sedimentation damage; (2) proper land use; (3) channel stabilization; and (4) improvement of the local economy.

Under this program, through June 1961, pine seedlings have been planted on more than 300,000 acres and timber stand improvement work has been accomplished on 93,822 acres. Ultimately two-thirds of the total area may be devoted to forest production. There has been a remarkable increase in intensive forest management of these woodlands. However, foresters and landowners alike need guidelines to assist in the management of these forest lands in accordance with approved practices, and to prevent the undoing of the remedial measures which have been undertaken.

OBJECTIVE

Watershed protection and improvement are of utmost importance for effective flood prevention within the Project area. Forest lands should be managed so as to stabilize and improve the water-holding capacity of the soil and to reduce surface runoff, at the same time providing a sustained yield of forest products upon which a sound economy can be built. These objectives can best be met by improving species composition, stocking, timber quality, and yield.






BASIC PRINCIPLES OF PROJECT TIMBER MANAGEMENT

1. Watershed protection and improvement are of primary importance.

2. Measures must be taken to protect the forest from destructive fire, grazing, insects, and disease.

3. Forest sites should be classified into species capability classes, i.e., pine, pine-hardwood, and hardwood.

4. The forest should be managed by stands rather than by individual trees.

5. All timber to be cut should be marked.

6. The first cut should rid the forest of diseased, damaged, poor-quality, and overmature trees while providing for the regeneration of understocked areas.

7. Timber stand improvement and/or tree planting are almost always needed on all forest holdings.

8. A growing stock goal should be set up for each species-site complex in accordance with the owner's objectives to guide management methods.

9. The advice and assistance of a professional forester in managing and marketing timber will prove to be invaluable.

10. Consideration should be given to the multiple-use aspects of land management—recreation, game habitat, hunting, etc.








THE FOREST

Fifty percent—1,995,000 acres—of the 4.2 million acres within the Project is now forested according to the 1957 Forest Survey. Sixty-three percent of this forest land was once farmed. There are 443,000 acres of loblolly-shortleaf pine; 416,000 acres of oak-pine; 915,000 acres of oak-hickory; and 221,000 acres of bottomland hardwoods. Nearly two-thirds of the forested area is in ridges, upland flats, and slopes suitable for pine. The remaining third is in lower slopes, terraces, and bottoms where hardwoods do better.

Only 43 percent of the forested area is well-stocked while 24 percent is either poorly stocked or non-stocked. There are 351,000 acres of sawtimber; 646,000 acres of poletimber; 930,000 acres of seedlings and saplings, and 67,000 non-stocked acres. The average stand per acre in the loblolly-shortleaf pine type is 1219 board feet; in the oak-pine type, 679 board feet; in the oak-hickory type, 1019 board feet; and in the bottomland hardwood type 1741 board feet. Fifty-nine percent of the sawtimber stands are of poor quality; i.e., there are fewer than four grade 2 or better logs present per acre. Annual growth per acre averages but 75 board feet for sawtimber or one-third of a cord for all timber.

Fire, woods grazing, overcutting, lack of an adequate pine seed source, and an overabundance of cull hardwoods have handicapped improvement in forest conditions. Forest fires, which in the past had burned over 89 percent of the area, are on the wane. Organized protection by the Mississippi Forestry Commission has reduced the average annual burn to less than 0.3 percent of the protected acreage.

On twenty percent of the forested area woods grazing is a problem. Heavy yearlong grazing prevents the establishment of valuable hardwood seedlings such as yellow-poplar. It also compacts the soil increasing runoff and sediment production. Sixty-nine percent of the forest is in poor or very poor hydrologic condition.

Three-quarters of a million acres of low value hardwoods on the Project should be converted to pine.

While 80 percent of the loblolly-shortleaf pine stands are already adequately stocked with pine or have an adequate pine seed source, 70 percent of the oak-pine forest and 98 percent of the oak-hickory type lack an adequate pine seed source. Approximately one-third of the total hardwood volume is in cull trees.

Cull tree removal needs to be done on 1,376,000 acres within the watershed. This includes the release of pine from undesirable hardwood competition on 226,000 acres; the removal of low-grade hardwood to make way for natural pine restocking on 100,000 acres; and the conversion of 1,050,000 acres to pine by planting and deadening the hardwoods.

From 1946 through 1960 the Project planted 306,000 acres to pine. This included 108,000 acres of critically eroded land, 120,000 acres of open land on farms and 78,000 acres of type conversion. Approximately half of this planting has been done since the 1957 Forest Survey. These 306,000 acres of pine plantations are worthy of special attention since they are potentially the area's most productive forests and are the nucleus around which an expanding forest economy will be built.

Well-stocked, mature stands of pine make maximum contribution to watersheds and local economy.

SOILS

There are five physiographic soil areas within the Project; the Brown Loam, Mixed Loess and Coastal Plain, Sand-Clay Hills, Flatwoods, and Pontotoc Ridge.

Buff colored silt of glacial origin was picked up from the Mississippi and Ohio River flood plains by winds and deposited east of the valley on the gravel, sand, and clay of the Coastal Plain to form the Brown Loam. The depth of this loessial deposit varies from 20 to 60 feet on the western side and gradually thins out as it extends eastward to become the Mixed Loess and Coastal Plain area where the loam is less than 3 feet thick. The original topography upon which the loess was deposited and the ensuing erosion make the boundaries of this province very difficult to delineate.

The Brown Loam soils were developed under forest cover and in a humid, temperate climate. They are situated on gently rolling, moderate- to well-drained uplands in parent material which is not extreme in its texture or chemical composition. These soils are characterized by a low accumulation of organic matter in the surface layer, a leached surface horizon, and a thick zone of mineral accumulation. Erosion is spectacular with approximately 50 percent of the area affected by severe or extremely severe erosion.

In the Brown Loam, Memphis, Loring, and Grenada soil types are found on the ridges and slopes; Calloway and Henry in the upland flats; Lintonia, Richland, and Olivier in the terraces; and Vicksburg, Collins, Falaya, and Waverly in the bottoms.

Common soil types in the Mixed Loess and Coastal Plain include; Lexington, Providence, Dulac, Tippah, Falkner, and Tickfaw in the uplands; Dexter, Freeland, and Hatchie in the terraces; and Shannon, Hymon, Ina, and Beechy in the bottoms. The same terrace and bottomland soils occur in both loessial physiographic provinces.

The Sand-Clay Hills are characterized by low, steep hills, and rugged topography. Erosion has been very severe in the uplands and much of the land formerly farmed has reverted to forest. Common upland soils include Orangeburg, Atwood, and Ruston derived from sand and sandy clays; Ora, Savannah, and Pheba from sandy clays and with hardpans; Shubuta and Cuthbert from stratified clays and sands; Boswell and Susquehanna from heavy clays and shales; and Providence and Dulac from silty material over brittly clays. Myatt, Dexter, Freeland, Hatchie, and Almo are common terrace soils. Bottomland soils include Iuka, Mantachie, Bibb, Shannon, Hymon, Ina, and Beechy.

Soils in the Flatwoods are generally heavy and not as productive as those of the other areas. Although erosion is not severe, moderate sheet erosion is general and gullies are not infrequent. Common soils are Tippah, Falkner, Pheba, Wilcox and Lufkin in the upland; Freeland, Hatchie, and Almo on the terraces; and Iuka, Mantachie, Bibb, Ina, and Beechy in the bottoms.

The Pontotoc Ridge has highly productive upland alluvial soils. Approximately 45 percent of this physiographic area has been seriously affected by severe sheet and gully erosion, and much of the land has been rendered totally unfit for crop use. The numerous gullies are fairly shallow with firm, rounded banks and being contiguous, the gullies give the eroded slopes a distinctive corrugated appearance. Common upland soils are Red Bay, Orangeburg, and Ruston from deep sandy materials; Ecru, Atwood, and Lexington from silt, sand, and clay; Mayhew from heavy sandy clays over chalk; Ora, Savannah, and Pheba from sandy clays with hardpans; and Beauregard from sandy clays and clay. Dexter, Freeland, Hatchie, Almo, and Myatt are some of the terrace soils. Bottomland soils include Iuka, Shannon, Hymon, Ina, Beechy, and Bibb.

Over 100 million tons of sand and sediment wash out of the hills each year into the valleys and stream channels.

TIMBER MANAGEMENT PRACTICES

Species Site Relationships

The early settlers found north Mississippi to be a region of fertile soils traversed by clear, deep streams and supporting an abundant wildlife in dense, almost unbroken forests of hardwoods and conifers. The growing of clean-tilled crops of corn and cotton on the hills without conservation measures resulted in severe erosion and flooding. The degree of this erosion dominates soil-site assessment throughout the Project area.

The shortleaf-loblolly pine type occurs naturally in the southern portion of the Brown Loam and Mixed Loess and Coastal Plain, in the Sand Clay Hills, in the northern tip of the Flatwoods, and on Pontotoc Ridge. On all eroded sites and on sandy upland soils loblolly pine is the preferred species for establishing forest cover.

In the Brown Loam area the deep loess sites grow good pine although cherrybark, Shumard, and white oaks do well on uneroded ridges and upper slopes. Sweetgum as well as the aforementioned species will grow on upland flats. On the middle slopes the degree of erosion and the amount of hardwood reproduction should govern selection of species to favor. Ash, cedar, cherrybark, Shumard, southern red, water, white and willow oaks, sweetgum, and yellow-poplar should do well on uneroded sites and on many terrace sites. Pine is to be preferred on eroded or open slopes.

Branch heads, coves, and lower slopes may produce excellent hardwood timber. Yellow-poplar, cherrybark oak, Shumard oak, sweetgum, white ash, and sassafras do well in the Brown Loam Bluff area. Cottonwood and sycamore are found occasionally on the best cove sites and dogwood is common on the slopes.

In the Mixed Loess and Coastal Plain upland and terrace shallow loess soils overlying sandy, sandy clay, or gravelly material are fair to good sites. The sandier the soil, the more pine is to be preferred. Upland shallow loess overlying heavy clays or marls are fair to poor pine sites. Cherrybark, Shumard, southern red, water and white oaks, sweetgum, and yellow-poplar are the preferred hardwoods on deep soils of the mid and lower slopes.

Good pine sites in the Sand Clay Hills are found on well-drained upland soils and terrace soils derived from sands and sandy clays. Upland soils with pans are fair pine sites, as are those upland soils derived from heavy clays and shales, or from silty material over brittle clays. Well-drained terrace soils derived from heavy clays and shales or from silty material over brittle clays will grow pine, but hardwood competition will be severe. On poorly drained terrace soils derived from heavy clays and shales or from silty material over brittle clays, hardwoods should be favored.

Soils in the Flatwoods area have poorly or imperfectly drained subsoils and are fair to poor pine sites. Cherrybark, Nuttall, water and willow oaks, green ash, and sweetgum should be favored.

Well-drained upland soils on Pontotoc Ridge derived from sands, sandy clays, and sandy clays with pans are good pine sites. Terrace sites derived from sandy materials will also grow good pine. Terrace soils derived from sands and clays, heavy sandy clays over chalk, and from heavy clays that are poorly drained are predominantly hardwood sites.

In the bottomlands on the higher, better drained bars and towheads, the pioneer species is cottonwood. When cottonwood matures, it is succeeded by the riverfront species—silver maple, American elm, hackberry, sycamore, boxelder, and pecan. Later a succession of water oak and sweetgum and ultimately cherrybark oak on the best sites follow.

On high ridges in second bottoms white oaks, black tupelo, winged elm, white ash, and hickory are found along with cherrybark and Shumard oak, water oak, and sweetgum. These species are also common in the bottoms of small, fast-moving rivers and large creeks and on the terraces of the slower moving entrenched streams.

On low, newly-formed bars with fine-textured soils, the first pioneer is usually willow. If the site fails to gain elevation, successors are baldcypress and green ash, sometimes in association with American elm, red maple, and sugarberry, followed much later by overcup oak, water hickory, and persimmon. If sedimentation is pronounced, the site may eventually support Nuttall oak.

In the broad slackwater areas of the first bottoms, the low ridges typically carry sweetgum, willow oak, green ash, and occasionally water oak. Sugarberry, Nuttall oak, overcup oak, red maple, American elm, and green ash are the usual species on the flats and lower ridges.

Species composition on low ridges of second bottoms is similar to that on the high ridges or ancient fronts. The most common species are swamp chestnut oak, cherrybark oak, Shumard oak, water oak, black tupelo, and winged elm, with some hickory and white ash. Here the flats are usually occupied by sweetgum, willow oak, Nuttall oak, green ash, red maple, and persimmon—species characteristic of low ridges and better flats in the first bottoms.

Upland Pine-Hardwood Management

Only 27 percent of the forest land in north Mississippi is better suited for growing hardwoods than for pine. On perhaps another 10 percent of the area—the lower slopes, banks of intermittent streams, and lower coves—good hardwoods will grow well and compete with pine. The ridge tops, upland flats, upper and most middle slopes and those lower slopes on which small hardwoods of desirable species are not well established should be converted to pine.

The first step in placing land under management is to classify it into capability classes: pine, pine-hardwood, and hardwood. Then stock should be taken of what is present on each site. The forest should be managed by stands rather than by individual trees. It is not only easier to manage pure timber types but production will be greater. Isolated hardwoods, for

example, should not be reserved in ridge-top pine stands unless desired for game food. It is best, however, to select and favor crop trees within stands, i.e., trees which will make high quality sawlogs, veneer logs, or poles.

In the shortleaf-loblolly, pine-hardwood and oak-hickory types efforts should be made to increase pine stocking on eroded, dry, and sandy sites. An improvement or conditioning cut should come first, unlimited as to the volume removed so long as the minimum operable cut per acre is attained. In many cases this may require clear-cutting all merchantable stems and then planting the area.

If there are six or more seed bearing pine left per acre and the soil is bare or the litter sparse, the cutover area can be naturally regenerated. If there is any doubt, however, as to the possibility of success, the openings and areas stocked with low-quality hardwoods should be immediately planted with loblolly pine. Seedlings should be released at planting time and again 3 years later if hardwood sprouts are overtopping them.

Along cove bottoms and on moist lower slopes well formed cherrybark, Shumard, and white oaks; and sweetgum and yellow-poplar can be left. Natural regeneration should be relied on in cutover stands on these sites. Hardwood planting stock is scarce and it should be devoted to reforesting open areas on terrace and minor bottom sites.

In well-stocked stands pine should be managed in even-aged stands using a heavy seed tree system (approximately ten seed trees per acre) to regenerate the stand when the trees are 60-80 years old and/or 18-20 inches in diameter. Pine-hardwood stands should be cut selectively with both pines and hardwoods on most slope sites attaining maturity when 18 to 22 inches in diameter. Pure upland hardwood stands are usually composed of heavy seeded species and should be managed selectively. Occasionally pure stands of gum will be encountered which should be managed like even-aged stands of pine except that on the best sites the stands should not be regenerated until the tops show signs of breaking up. Pine management should be aimed at volume production and hardwood management at quality of product.

Growth data on trees and stands in the uplands are scarce. In one study 10-year diameter growths on ridge, middle, and upper slopes were shortleaf pine—1.74″, white oak—1.60″, post oak—1.0″, southern red oak—1.58″, and upland Shumard oak—1.48″. These growth rates would certainly have been better had the stands been under management throughout their existence.

Sawtimber growth rates were 4.1% for the white oak group, 4.6% for the red oak group, and 5.2% for shortleaf pine. Shortleaf pine stagnates much more quickly than loblolly and is much slower to respond to release. Thus conversion to loblolly should result in increased growth rates.

Individual shortleaf pine stands have grown at the rate of 560 board feet per acre annually but a goal of 400 board feet is probably more realistic. Loblolly pine should grow at a rate of better than 500 board feet per acre per year. Excellent upland stands of hardwoods are lacking but over most of the area growth of 300 board feet per acre should be attainable. Well-stocked all-aged pine and pine-hardwood stands, i.e., stands which have attained the growing stock goal, should be cut back at 5-year intervals to basal areas of 60 to 70 square feet and even-aged pine stands to 70-80 square feet.

The allowable cut depends on assumptions made as to growth, on arbitrary decisions as to desired future growing stock, on the time allowed to reach the growing-stock goal, and on the future intensity of silviculture. Until unmanaged stands have been subjected to at least one improvement cut, the allowable cut should not be limited by periodic growth. After the improvement cut small ownerships should cut much less than the growth, even though regular harvests at short intervals may not be possible until the property has been under management for many years.

To determine the growth rate it will be necessary to cruise the stand immediately following the improvement cut and to repeat the inventory at periodic intervals, preferably 10 years. Most allowable cut formulas provide for a constantly increasing allowable cut as the stand approaches the growing stock goal. For simplicity's sake and to speed rehabilitation of north Mississippi's forests it is recommended that no more than 50 percent of the periodic growth be cut until the growing stock goal is attained. Since the minimum operable cut is 1,000 board feet per acre, it may be necessary to defer the first harvest cut for 15 to 20 years after which subsequent harvest cuts can be made at 10-year intervals. Until further information is available an arbitrary growing-stock goal of 10,000 board feet per acre (Int. ¼″ Rule) should be used.

Marking in Upland Stands.

In second-growth stands the timber marker should concentrate on leaving a well-spaced stand of healthy, high-quality pine timber. All merchantable upland hardwood 13 inches d.b.h. and larger should be removed except those needed to provide game food.

Oak-pine stands should be marked to leave a well-balanced stand of healthy, high quality pine and hardwood timber of the more valuable species (loblolly pine, shortleaf pine, white oak, cherrybark oak, Shumard oak, ash, yellow-poplar, and sweetgum).

Healthy, good form, high quality hardwood of the better species should be left in oak-hickory stands. All merchantable trees of inferior species (red oak, black oak, hickory, etc.) should be marked where their removal will benefit established pine reproduction or hardwood saplings of desirable species. Trees of the better species which promise to produce less than two logs can also be removed. A relatively complete list of upland species showing the order in which they are to be favored is given in table 1.

In all three timber types trees should be marked in the order designated below:

1. Sanitation trees.
2. Poor risks.

3. Wolf trees.
4. Mature and overmature trees.
5. Poor quality trees.
6. Poor form trees.
7. Thinners—primarily pine.

Doubtful trees should be left as they can be taken on the next cut. Don't mark too high a percentage of low-grade and cull trees. An abundance of marked trees too small, too low in quality, or too unsound to be usable will drive buyers away. Trees of questionable merchantability should be marked with an "X." The buyer should be told that such trees are free and that he can cut or leave them at his discretion. This practice will often reduce substantially the cost of doing timber stand improvement work.

Marking for an improvement cut is relatively easy. Decisions become harder as stand quality improves and tree vigor becomes an important consideration.

Tree vigor, an important criterion in timber marking, can be judged from external factors. Bark features are such a reliable indicator of vigor that some others—site, age, root system—can largely be ignored. The crown, however, furnishes additional evidence and should be considered.

Red oaks of high vigor generally have smooth, thin bark with wide, open fissures vividly colored at the bottom. As vigor declines, the bark thickens and roughens, and the fissures narrow, becoming discontinuous and obscure in low-vigor trees. Decadent red oaks, those below the class of low vigor, are usually degenerate or dying. The bark is thick, dark, and very rough or dull, bleached, and sickly in appearance. Excessive die-back of twigs often makes the tree stagheaded.

White oaks of high vigor generally have thick, dark-gray bark with distinct, long fissures; ridges are flat with few cross breaks. As vigor declines, the bark thins and turns ash-gray, while fissures become obscure, ridges scaly, and cross breaks more numerous. The most conclusive indicator of decadence is one or more faces with very thin bark.

Yellow poplars of high vigor generally have bark that is shallowly ridged, somewhat corky, and light ash-gray. The fissures display light-colored inner bark at the bottom. As vigor falls off, the ridges become more distinct and closer together, and the color darkens. The inner bark tissue disappears as low vigor is reached. Decadent yellow-poplars have very pronounced fissures, and the bark is bleached and sickly.

High vigor hardwoods have crowns 3/4 or more fully formed and without close competition; medium vigor hardwoods have crowns 1/2 or more fully formed and without close competition; and low vigor hardwoods have small crowns, poorly formed or open.

Pines of high vigor have a rough bark with deep fissures at the bottom of which light colored inner bark is displayed. As the vigor declines broad flat plates of bark develop with thin scales, the fissures narrow, and the crown of the tree flattens out.

Growth rates to be expected in the tree vigor classes follow:

Ten-year average diameter growth (inches)

Vigor	*Red oaks*	*White oaks*	*Yellow-poplar*	*Pine*
High	3.0-4.0	2.0-3.0	3.5-4.5	3.0-4.0
Medium	2.0-3.0	1.5-2.0	2.5-3.5	2.0-3.0
Low	1.0-2.0	1.0-1.5	1.5-2.5	1.0-2.0

An increment borer should be used occasionally to check ocular estimates of tree vigor.

When trees of low or medium vigor are to be released by cutting, they should be promoted one vigor class before judging their financial maturity. Trees which show immediate promise of improvement in vigor class, grade, or stem length should be permitted to grow at least one more cutting cycle. Where one of two competing trees is to be cut, it is best to take the one of lesser size, grade, or vigor, or the one with poor prospects for improvement.

The potential rapid improvement in grade in pine has been realized by the time a tree reached 20 inches d.b.h. and the potential merchantable length is usually established by the time the tree is 16 inches in diameter. All low-vigor pine above 16 inches as well as most trees 20 inches and over in north Mississippi should be considered mature.

Hardwoods unlikely to meet lumber-log standards in the future should be cut when 14 to 16 inches in d.b.h. Most of the potential rapid improvement in grade, even on the better sites, will have been reached by the time the tree reaches 24 inches d.b.h. The 16-inch d.b.h. class is the smallest size from which hardwood factory lumber can be produced economically and the 24-inch d.b.h. class is a good maximum size.

Table 1.—*Species Marking Guide for Upland Stands*

Always favor	Favor on hdwd. sites	Cut all but best specimens	Leave for game food	Always cut
Loblolly pine	Yellow-poplar	Southern red oak	Dogwood	*Hickory
Shortleaf pine	White ash	Black oak	Wild plum	Elm
Redcedar	Cherrybark oak	Post oak	Holly	*Beech
	White oak	Water oak	Sassafras	*Blackgum
	Sweetgum	Willow oak	Persimmon	Blackjack oak
	Shumard oak	Red maple	Mulberry	Upland Shumard oak
		Sycamore	Black cherry	
		Black locust		

*May be left where needed for game food.

Good upland hardwood stands are rare on the Yazoo watershed.

Pine Plantation Management

Plantation management during the next 30 to 40 years is going to consist largely of thinning. The chief functions of thinning are to salvage present and incipient mortality; to stimulate the growth of crop trees; and to provide early income. There is little evidence to show any increase in gross production of cellulose in thinned stands over unthinned stands before age 35. Stocking and system of thinning to use are governed to some extent by the objectives of the landowner. In this area the objective should be to grow high quality sawlogs and pulpwood while maintaining maximum site protection. Thus the thinning system should concentrate on putting diameter growth on selected sawlog crop trees while harvesting surplus trees for pulpwood.

Fully stocked 15- to 20-year-old pine stands should be thinned from below while open grown stands should be thinned from above the first time to favor trees which will produce high quality sawlogs—the crop trees. These crop trees should be selected from among the very best dominants and codominants at the rate of 100 per acre. This allows a safety factor of 100 percent for losses during the rotation.

In order to facilitate plantation logging and to minimize damage, access roads should be marked at two-chain intervals. This rule can be altered to take advantage of the stand composition or the topography. Frequent roads prevent excessive rutting and soil exposure, thereby reducing the danger of erosion.

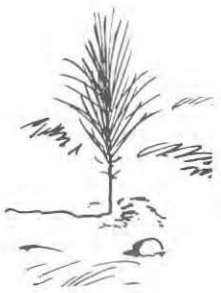
Markers often spot all rough, diseased, damaged, suppressed, and dying trees without regard to what is left. This results in large openings which will grow hardwood brush and briars and tight pine clumps, which will grow wood, but not at the rate desired. The timber marker should pay more attention to the trees to be left than those to be taken. The trees to be left are those which will bring in the big returns.

No tree that will retain its value until the next cutting cycle should be taken unless its removal will benefit some other tree. Wolf trees should be removed, where possible, at the time of the first thinning since they suppress more and more of their fellow pines as they age and their removal, when delayed, leaves a hole that takes several cutting cycles for the surrounding pine to re-occupy. Little marking should be done in gullies except for salvage and the gully edges should be spotted lightly. Because of the lasting pattern that the first marking sets up, it is particularly important that a slow, painstaking job be done at this time.

The thinning prescription, in brief, follows. First, mark access roads at 2-chain intervals, taking care that they are so located as to minimize the danger of erosion. Then selectively mark the rest of the stand to favor 100 crop trees per acre. These should be located approximately 21 feet apart where possible. Don't try to take out all the poor trees in the first cut. Bank some of them on the stump for future cuts. If the removal of any tree will leave a hole which will grow nothing but hardwood brush, leave it. Cut the stands back to a basal area of approximately 85 square feet on good sites and 70 square feet on fair sites if quality sawlogs are the primary objective of management. Leave basal areas 15 feet higher than those if maximum pulpwood production is desired. Check the marking with a 3-diopter prism.

The minimum operable cut per acre should be 3 cords. On sites of 80 or better a 3-year cutting cycle is feasible for loblolly pine; on poorer sites use a 5-year cutting cycle. On average sites well-stocked loblolly plantations will grow at the rate of 1.5 cords per acre per year; shortleaf plantations 1.0 cord per acre per year. Sawlog rotations should be 60 to 80 years, pulpwood rotations 35 to 40 years.

At the rotation's end pine plantations can be regenerated with seed trees, but many landowners will prefer to clearcut and plant to avoid delay.



This is a 22-year-old loblolly pine plantation after two thinnings.

Bottomland Hardwood Management

Hardwood forest management objectives and the type and intensity of silviculture are governed by utilization standards and the markets available. A good understanding of use classes and log grades is highly essential. Hardwood management is aimed at the production of quality timber. The greatest single use of southern hardwoods is for factory lumber. Grades 1 and 2 factory-lumber logs find ready markets at fair to excellent prices nearly everywhere. Veneer and cooperage logs seldom lack a good market if available in quantity. Hardwood lumber logs are commonly shipped up to a hundred miles, and mills producing face veneer may reach out several times that distance.

Successful hardwood silviculture and management is based upon species-site relationships. Most hardwood stands have been so badly abused that the first step should be an improvement or conditioning cut. This cut will remove low-grade, deformed, or damaged trees that have a poor future or are interfering with better trees. To market trees of this quality, it is generally necessary to include a number of high-grade trees that are mature, over-mature, short stemmed, or off-site. The period for removal of the undesirable trees should not be more than 10 years in order to salvage mortality and to regenerate unproductive areas.

Desirable, fast-growing, southern hardwoods are intolerant. Adequate advance reproduction of sapling size and of these species seldom develops except in openings large enough to provide sunlight for a substantial part of the day. Where such openings occur, virtually impenetrable brush patches develop. Within a few years the thicket will begin to melt away, leaving a stand of 400 to 1200 saplings. Fortunately, the better species and the best-formed trees tend to grow most vigorously and to assert dominance, suppressing the less desirable species. If there is a desirable sapling free to grow every 12 to 15 feet, the area will be fully stocked by the time the trees reach pulpwood size.

Nuttall oak, willow oak, water oak, and overcup oak will germinate profusely beneath a complete canopy but the seedlings will die back to the root-collar within 3 years unless released. The ashes and most oaks will germinate throughout the stand with scattered individuals existing for some years in the partial light of small openings. Cottonwood and willow require absolutely bare, moist mineral soil for the first few weeks of growth. Baldcypress regenerates well only in swamps where seedbeds are moist, where competitors are unable to cope with flooding, and where ground cover is limited to annual herbs. Even-aged stands of sweetgum often come in on old fields and other areas where mineral soil is exposed. Once they germinate, sweetgum seedlings can withstand very heavy competition from herbaceous plants. Cottonwood, willow, tupelo gum, and cypress can survive heavy siltation.

Planting may be necessary on areas where reproduction is lacking and a desirable seed source absent, or where it is desired to return abandoned cropland to trees. Hardwood plantations require more care than pine and will not do well if untended. Cottonwood, recommended for planting on the flood plains of large

An 85-year-old cypress stand in a minor stream bottom with 318 square feet of basal area and 60,000 board feet per acre (Int. ¼" Rule).

rivers, requires site preparation and 2 to 5 cultivations the first growing season for successful survival and growth. Although much remains to be learned about planting hardwoods, species with good planting prospects include white and green ash, cypress, swamp tupelo, sweetgum, sycamore, yellow-poplar, and cherrybark, cow, Nuttall, Shumard, and willow oaks.

During the early stages of management, undesirable growing stock and culls must be removed, and balancing harvest against growth is neither necessary nor desirable. Once the initial improvement cuts have been made it is necessary to adopt a silvicultural policy that will insure good development of immature trees, bring about reproduction when needed, and establish a system of volume control.

Cottonwood, willow, sweetgum, baldcypress, yellow-poplar and tupelo occur in extensive even-aged stands and may be managed as such. The silvicultural system will usually be seed tree. Cottonwood and willow cannot be easily regenerated by this or any other system but the riverfront hardwoods that follow them are usually successful.

Some system of selection cutting should be used in most other hardwood stands with cut limited by volume rather than by area. These forests are at present primarily many-aged although they may be composed of small, even-aged stands of various ages. Trees or groups should be marked or left on their individual merits. Cleaning, thinning, release, and harvest will be based on consideration of the quality and needs of the individual tree in comparison with those of its neighbors. Some idea of the relative desirability of some of the bottomland hardwoods is given in table 2.

Placement of the forest under permanent management will require the establishment of a series of permanent growth plots from which a stand table showing numbers of desirable growing-stock trees and their volume per acre by species and diameter class can be developed. During the first 10-year cutting cycle, it will be safe to use a growth percentage of 5 percent simple interest to compute the first periodic cut. This cut preferably should remove only 50 percent of the periodic growth but it may be necessary to exceed this to obtain a minimum operable cut of 1,000 board feet per acre.

In uneven-aged management there is no fixed rotation age for harvesting stands or trees. The prospective growth rate and the relative value increase of individual trees determine their maturity. Growth should be concentrated on large, vigorous, high-grade trees. Stands should be managed to have as many of the larger sizes and as few of the smaller sizes as possible —just enough of the small ones to replace the large as they are harvested. Trees 28 to 32 inches d.b.h. will be the usual mature sizes on reasonably good sites but some exceptionally good 36-inch or larger trees may be grown another cycle or two for special products like face veneer. Residual basal areas—2 inches d.b.h. and larger—for well-managed uneven-aged southern hardwoods on average or better sites should be 65 to 70 square feet per acre. Growth per acre per year should be close to 500 board feet.

In even-aged management the rotation may be as short as 40 years for cottonwood and willow but for other species will probably be from 80 to 120 years on all but the poorest sites. Residual basal areas for sawtimber-sized stands following cutting and annual boardfoot growth rates for some bottomland species follows:

Species	*Residual basal area Sq. ft.*	*Annual growth per acre Bd. ft.*
Cottonwood and willow	100-105	600-800
Sweetgum & yellow-poplar	135-140	600-700
Tupelo	125-140	600-700
Cypress	135-150	700-800
Others	130	500-600

Residual basal areas following cutting in pulpwood-sized stands of the species above should range from half to two-thirds of those specified for sawtimber stands.

Diameter-growth rates, that might be expected from unmanaged woods-run hardwoods in favorable competitive positions on average bottomland sites, derived from data gathered by the Forest Survey are given in table 3. Under intensive management on good sites the growth rates shown in table 3 might be increased 30 percent.

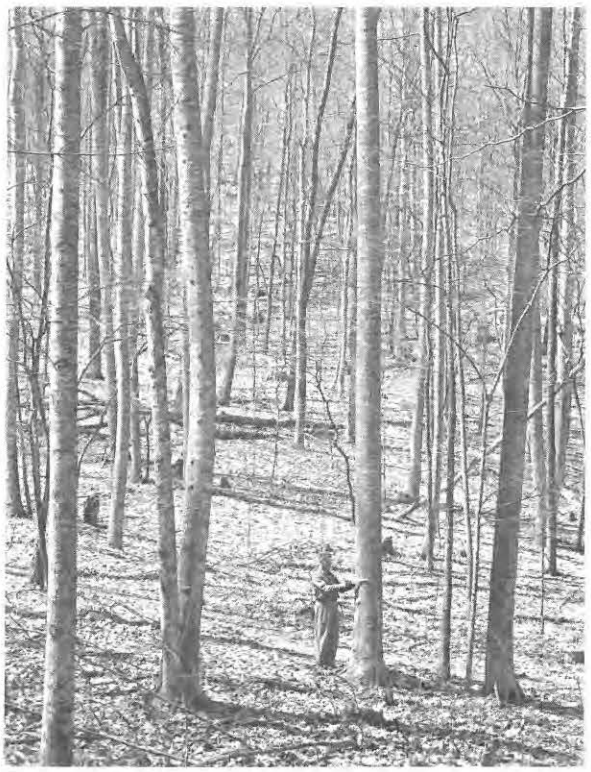
Tree vigor classes, as estimated ocularly from bark features and crown condition, are of great value in determining what trees to cut or leave in stands 16 inches d.b.h. and larger. Vigor characteristics of the bottomland red oaks—cherrybark, Nuttall, water and willow—are quite similar to those given for upland red oak.

In contrast with the red oaks, sweetgum trees of the highest vigor are characterized by the thickest bark, with distinct high ridges, and streaks of very light inner bark at the bottoms of fissures. Sweetgum of medium vigor have bark with rounded ridges, free of scales and narrow fissures only occasionally displaying a thin streak of inner bark. Low vigor trees have a dark, thin, flat bark which may be scaly and with no display of inner bark.

Crown vigor indications are similar to those of the red oaks but the limbs become heavier and the foliage less abundant and lustrous as the vigor declines with those of low vigor frequently stagheaded or dry-topped.

Growth rates associated with these vigor classes are as follows:

Vigor class	*10-year diameter growth (inches)*	
	Bottomland red oaks	*Sweetgum*
High	3.5-4.5	3-4
Medium	2.5-3.5	2-3
Low	1.5-2.5	1-2



Well drained minor bottoms on the Project can grow good stands of yellow-poplar.

Table 2.—*Species marking guide for bottomland hardwood stands*

Always favor	Desirable	Less desirable	Always cut
Ash	*Willow oak	Red oak	Bitter pecan
Sweetgum	*Water oak	American elm (ordinary)	Winged elm
Yellow-poplar	*Nuttall oak	*Hackberry (ordinary)	Rock elm
*Cherrybark oak	Cottonwood	Maple	Waterlocust
Cypress	Overcup oak (second growth)	*Sweet pecan	Box elder
Forked leaf white oak	*Persimmon	*Blackgum	Honeylocust
Cow oak	Sycamore	Overcup oak (over mature)	Birch (ordinary)
Shumard oak	Tupelo	Birch (best specimens)	Willow (ordinary)
Delta post oak	American elm (best specimens)	Willow (best specimens)	Hickory (ordinary)
*Willow oak (in spots)	*Hackberry (best specimens)	Hickory (best specimens)	
*Water oak (in spots)		Mulberry	

*Important game food trees.

Table 3.—*Ten-year average diameter growth rates for trees free to grow in unmanaged stands on average bottomland sites*

Species	Diameter class			
	6-12 inches	14-18 inches	20-28 inches	30+ inches
Sweetgum	2.80	2.85	3.05	2.30
Red oaks	3.60	4.30	4.45	3.25
White oaks	2.40	2.50	2.90	2.70
Ashes	2.05	2.30	2.85	2.65
Tupelos	2.85	3.15	3.25	3.00
Pecan	2.60	3.55	3.60	3.10
Cottonwood	6.30	5.85	6.30	4.65
Willow	3.80	5.45	5.50	4.20
Overcup oak	2.05	2.20	2.10	2.15
Water hickory	1.95	2.00	2.30	2.55
Baldcypress (second growth)	2.30	2.60	3.20	2.70
Miscellaneous rapid growers [1]	3.20	3.30	3.80	3.70
Miscellaneous slow growers [2]	2.00	2.10	2.50	2.30
Average	2.55	2.80	3.00	2.80

[1] American elm, maples, American sycamore, honeylocust, waterlocust.

[2] Cedar elm, winged elm, black tupelo, hickories, sugarberry.

Timber Stand Improvement Methods

The method to be used will be dependent upon the size of the trees to be deadened, the size of the trees to be released, the equipment easily available, and the experience of the labor to be used.

Frilling or girdling with axes requires the least investment and is the easiest method to start in areas where stand improvement work is new. Trees 4″ d.b.h.-10″ d.b.h. should be frilled or girdled as close to the ground as convenient and the cut surface treated within 20 minutes with a 20-pound ahg (acid per hundred gallons) solution of 2,4,5-T in diesel oil. Trees that are hard to kill such as hickory or sweetgum should be deeply girdled or peel girdled. Trees 10″ d.b.h. and larger can be safely frilled or girdled without the addition of 2,4,5-T since larger trees do not sprout prolifically. Trees less than 4″ d.b.h. should be cut off close to the ground and the stump surface treated with a 20-pound ahg solution of 2,4,5-T in diesel oil.

Local experimentation may reveal that with certain species such as blackjack and post oak on dry sites, a 4-pound ahg solution can be used to prevent sprouting. Oil is recommended as a diluent rather than water because it gives faster, more reliable kills. Trees treated in the spring and early summer seem to die quicker and sprout less than those dosed at other seasons. Where vigorous pine reproduction 3 feet tall or taller is being released, the chemical is not needed unless ACP payments are desired.

Six axmen and a supervisor make an efficient crew for frilling or girdling and applying chemicals. Each axman should be equipped with fibre or metal leg guards and steel-capped shoes. Two tablespoonfuls of oil red dye should be added to each 20 gallons of solution to facilitate checking. The supervisor should mix the chemical and see that the axmen completely sever the cambium all the way around the tree and do not skip trees.

The Little Beaver Tree Girdler is an excellent tool to use in deadening hardwoods 4″ d.b.h. and larger. It makes a fast girdle—a man using a "beaver" was able to girdle 2.6 times as much basal area of hardwoods per hour as a man frilling trees with an axe. The same concentrations of 2,4,5-T should be used as when employing an axe. Crowns of trees girdled with a "beaver" will be slower to die than those on which an axe was used. "Beavers" are not suitable for use on hickory or on steep or rocky locations. Maintenance costs may be high unless a competent mechanic is on the crew.

Tree injectors are excellent tools to use where there are a great many small stems to deaden. Their use is not limited by terrain. Maintenance costs are low. They are not hazardous to personnel. There is little waste of chemical.

Injections should be spaced 2 inches apart (edge to edge around the trunk near the groundline) for red, post, blackjack, and white oaks under 9 inches in diameter. This corresponds roughly to 1 groundline jab per inch d.b.h. For trees of these species larger than 9 inches, the 2-inch separation should be reduced to 1 inch, or the concentration increased. For hard-to-kill species such as sweetgum, blackgum, elm, willow, water oak, and hickory the injections should be spaced 1 inch apart on stems under 9 inches and ½-inch apart for larger trees. ACP requirements call for spacing jabs 1″ apart for all sizes of trees.

Satisfactory results have been obtained using 20-pound ahg concentrations of 2,4,5-T ester (non-emulsifiable) in diesel oil; 2,4,-D and 2,4,5-T ester (non-emulsifiable) in oil; 2,4,5-T amine in water; 2,4-D and 2,4,5-T amine in water; and 2,4,5-T emulsifiable acid in water. When an ester form of 2,4,5-T is used it is best to use oil as a carrier. Concentrations of 40 pounds ahg are recommended for winter treatment.

Mist blowers are becoming increasingly important for site preparation and the release of pine seedlings where there is a dense cover of hardwood brush less than 25 feet tall. They are not suitable for use in rough terrain and require a D-2 type tractor or larger depending upon the terrain and ground cover. Portable mist blowers are satisfactory for treating spots of less than one-tenth acre in size.

Treatment is most effective when employed between May 15 and August 1. Where there are many young pine to release, 1.5 pounds of low-volatile 2,4,5-T plus 0.5 gallons of diesel oil and 3.25 gallons of water per acre should be used. In areas where there are no pine to release, 2 pounds of 2,4,5-T and 4.5 gallons of diesel oil per acre can be used. Newly germinated and 1-year-old pine seedlings will be killed or heavily damaged by mist blown 2,4,5-T of any concentration.

Aerial application of herbicides is not feasible where the pattern of land is fragmented since the risk of unintentional damage to crops is too great.

General—In areas where pine is to be favored, trees to be deadened need not be marked. The crew supervisor can designate game food and den trees to be reserved and can supervise the selection of trees to be killed on upland areas where the site is favorable for hardwoods and there are enough stems of good species to warrant reserving.

Trees to be killed in bottomland stands should be marked by a well-trained forester or technician. It is generally impractical to rely on the labor crew to select the trees to be deadened in these stands because of the complexity of silviculture and utilization.

Trees along roads should be felled or left untreated. Line or witness trees should not be treated.

Pruning

To obtain the greatest return in quality lumber from loblolly and shortleaf pine plantations managed on a 60-year or longer rotation it is necessary to prune the lower 8 to 10 feet when the crop trees are 16 to 20 feet tall and to come back when the trees are approximately 35 feet tall to prune to 17 feet. In this method the core of knotty wood is kept small on the first sawlog.

Some landowners may prefer, however, to wait until after the first thinning has been made and then to prune the first log in one operation. In this way costs can be paid from the thinning return and

pruning is facilitated by the thinning—some of the branches are knocked off by falling trees and the more open stands permit easier manipulation of the pole saw.

One log is all that it will pay to prune. Half of the volume and over two-thirds of the value of an 18-inch, 2½ log tree is in the butt log. No more than 100 released crop trees per acre should be pruned. The ratio of live-crown to total-tree height should not be less than 35 percent. As a rule it does not pay to prune trees larger than 8 inches d.b.h.

In a pruning time study made in a 17-year-old loblolly plantation and a 23-year-old shortleaf plantation, regression equations were developed from which pruning costs, using local wage rates, can be computed.

Loblolly pruned to 17 feet:

$$T = 6.4 - 1.4 \text{ d.b.h.} + 0.16 \text{ d.b.h.}^2 + 0.09 N$$

Loblolly pruned to 10 feet:

$$T = 3.7 - 0.73 \text{ d.b.h} + 0.06 \text{ d.b.h.}^2 + 0.06 N$$

Shortleaf pruned to 17 feet:

$$T = 0.13 - 0.12 \text{ d.b.h.} + 0.22N \text{ or}$$
$$T = 4.4 - 0.15 \text{ d.b.h.}$$

Shortleaf pruned to 10 feet:

$$T = 0.9 - 0.77 \text{ d.b.h.} + 0.008 \text{ d.b.h.}^2 + 0.14 N$$

Where T is pruning time in minutes and N is number of limbs pruned.

Shortleaf in this study was found to be cheaper to prune than loblolly because it had fewer and somewhat smaller limbs. The 16-foot log should not be considered sacred. Substantial savings in pruning costs can be made by switching to a clear log goal of 14 feet. Pruning the first 15 feet has been found to be relatively easy; the last 2 feet are disproportionately difficult.

Conversion Planting

Conversion planting consists of underplanting low-value hardwood stands with pine and immediately releasing the pine by deadening the hardwood overstory. Stands in which blackjack, post, and upland Shumard oak; hickory; and huckleberry predominate should be converted in entirety. Low-grade hardwood stands of other species on ridges, upland flats, and upper slopes and poor quality hardwood stands on eroded middle slopes should also be converted to pine. Pine plantations on such sites have reduced surface runoff four-fold.

Plant loblolly pine on a 6- x 8-foot spacing, release immediately, and return in 3 years for a second release if necessary. The objective here should be 75 percent survival at the end of the first growing season and production of a minimum of 500 pulpwood-sized trees per acre. With adequate hardwood control, pines on these sites have outgrown those planted on old fields.

Depleted upland hardwoods need conversion to pine.

It is impractical to plant openings smaller than a tenth-acre in sapling stands of young pine, lacking an adequate seed source. The same rule applies to interplanting pine in young stands of good hardwoods.

Low grade upland hardwood stand five years after conversion to loblolly pine.

Precommercial Thinning

Precommercial thinning should be limited to overly dense young pine stands of 2,000 or more stems per acre. The number of stems per acre should be reduced to about 600 to 1,000, depending on the site and crown condition. Loblolly and shortleaf pine stands should be thinned preferably before they are 5 years old.

This practice will be rarely resorted to. Some of the early erosion control plantings spaced 3 feet apart or less and some natural stands of shortleaf that originated on a burn or bare mineral soil may need this treatment. Shortleaf will benefit from precommercial thinning more than loblolly because of its tendency to stagnate when overly dense or on poor sites.

PROTECTING THE FOREST

Fire

Effective fire control is the number one remedial measure for the improvement of forest watersheds on the Project. Since 1955 the entire project area has received organized protection from the Mississippi Forestry Commission. The average burn in recent years has approached the goal of 0.1 percent of the protected acreage.

Forest values are increasing with 40,000 acres of new plantations added each year. Fire hazards are increasing too with thousands of acres of deadened hardwoods from TSI operations. Fires are particularly likely to occur on dry windy days in the late fall and early spring. The major cause of fires is the careless or indifferent debris burner.

An aggressive fire prevention program offers the greatest opportunity to reduce the number of fires. Some worthwhile measures are to:

1. Encourage field burners to surround areas to be burned with a plowed or disked line.
2. Instruct the public, especially known debris burners, on the relation of weather to the likelihood of fires escaping.
3. Publicize fire weather information, especially unsafe burning conditions, through local radio stations and newspapers.
4. Work for effective law enforcement.

It is advisable to plough firebreaks between young pine stands and well-traveled roads and highways. Large pine plantations should be broken into 40- to 60-acre blocks by firebreaks located along the ridges, where possible.

All fires should be attacked immediately at the point or points showing promise of the surest control with the least damage. This should usually be by backfiring from a plowed line at the head or forward flanks of the fire and from there working to the back. Breakovers may occur if fires are fought too closely. Fire flaps and backpack pumps are very effective in fighting grass fires threatening young pine. Fire rakes are most useful in fighting fires within the woods where litter rather than grass makes up most of the fuel.

No special precautions for slash disposal are necessary except along the roadsides where all tops should be lopped within 100 feet of the centerline. Care should be taken in logging, however, to keep tops out of streams or from lodging against leave trees.

Because of the emphasis on watershed values and the rolling topography, the use of fire as a tool in pine management is not recommended at this time within the Project.

It is advisable to plough firebreaks between young pine stands and well-traveled roads.

Future cutting must be done carefully here if soil stabilization provided by the pine needles is to be maintained.

Logging for Erosion Control

Complete layout of all roads and skid trails should be made in advance of construction—preferably in the fall or winter when the leaves don't interfere with seeing the lay of the land.

Water must be kept out of the roads and skid trails by constructing drainage dips; keeping the grades down to 10 percent or less; cutting the banks vertically; gravelling the roads near culverts, bridges, pitches, and where needed elsewhere; and seeding the road to grass or legumes when the logging job is through.

The roads should be kept out of the streams by locating them as far as practicable from the streams; crossing streams at right angles; and using culverts or bridges at all stream crossings.

Tree-length logs ought to be skidded uphill with power equipment, lifting the butt-end of the tree as it is skidded. Logs should always be skidded to the ridges between small draws, and never skidded across or along a stream. Repetitious use of skid trails should be avoided. Horse logging should be encouraged.

Good road and trail conditions during and after operations must be maintained.

Forest Pest Control

Although there are innumerable forest pests, the insects and diseases discussed below are considered to be those of the greatest immediate importance.

Tip Moth

The Nantucket pine tip moth (*Rhyacionia frustrana*) is the most common and widespread insect attacking young loblolly and shortleaf pine plantations in the South. It is becoming more important with the expanding planting program. Severe infestations not only reduce height growth in young trees, but stimulate excessive branching that results in forked or crooked stems.

The adults are about one-quarter inch long, copper-colored with silvery markings on their wings. They are active from February until late fall, but are not often seen unless disturbed. Eggs are laid on the foliage. The larvae are yellowish to pale brown, worm-like and up to 1/3-inch long when fully grown. They feed within the buds and twigs and later change into brown, capsule-like pupae about 1/4-inch long. Moths emerge from the pupae.

Terminals and branches of infested pines have many brown, dead, hollow buds and stunted twigs. A crust of hard, whitish resin can be seen between buds, needles, and twigs; and tunnels within dead buds and twigs contain granular brown, manure particles.

The most feasible method of avoiding severe damage is to encourage rapid growth through the use of vigorous strains and by planting species adapted to the site. Spraying the foliage with a mixture of 4 pounds of 50 percent wettable DDT powder per 50 gallons of water at times when moths are flying will control them but is expensive. Pines 15 feet or more in height are usually not damaged appreciably although large trees may be infested.

Black Turpentine Beetle

The black turpentine beetle (*Dendroctonus terebrans*) is one of the most serious pests of partially cut stands although its attacks are not always lethal. It is especially prevalent following fires, heavy cutting, droughts, windstorms, and other disturbances to the forest.

The adults are dark brown or black beetles 1/4- to 1/3-inch long. They bore into the cambial region and lay eggs there. The larvae, creamy white grubs up to 1/3-inch long, feed in groups in the inner bark and eat out large patches between bark and wood. When the attack is light the tree usually recovers. When beetle broods are numerous they girdle and kill the tree. At least 2 1/2 months are required to complete the life cycle of the beetle. Usually there are about two generations a year, but broods overlap.

The adult beetles are attracted by fresh resin and skinned or severely scorched bark. Populations may build up in fresh stumps and then spread to living trees. Infestations usually are worse on poorly drained sites although upland areas are by no means immune. They are common along woods roads and trails.

The most obvious signs of attack are conspicuous pitch-tubes on the lower trunk and stumps. The tubes are large—sometimes about the size of a walnut—and white to reddish in color. Older tubes have a sugar-like texture. Granular pieces of hard, whitish resin will be found on the ground below the pitch tubes. The tunnels and irregular excavations beneath the bark are packed with sticky resin and red boring dust. When ambrosia beetles have entered the tree, their whitish boring dust will also be seen around the base. Trees having the dust of ambrosia beetles around the base may be considered doomed to die.

Logging should be done in such a way as to minimize injury to the remaining trees. When outbreaks are likely, the green stumps and areas of skinned bark on remaining trees should immediately be sprayed with 0.50 percent gamma isomer benzene hexachloride in No. 2 diesel oil to the point of runoff. This spray can be prepared by stirring two gallons of benzene hexachloride concentrate (containing about one pound of gamma isomer per gallon) into about 50 gallons of No. 2 diesel oil. Before treatment, debris and litter should be scraped from around the tree or stump, so that the spray can penetrate to the base of the larger roots.

Where salvage is feasible, the dead or dying trees should be cut and milled as soon as possible; the slabs from the butt logs should be burned in the mill yard. If the stumps are still infested they should be sprayed.

Fusiform Rust

Fusiform rust, caused by the fungus *Cronartium fusiforme* is one of the most serious diseases in southern pine forests. This rust kills huge numbers of seedlings and disfigures and weakens the stems of larger trees. Loblolly and slash pines are particularly susceptible while longleaf pine is moderately resistant and shortleaf pine highly so.

Oaks are the alternate hosts of the rust. Water, willow, and laurel oaks are most susceptible. Next in susceptibility are blackjack, southern red, and turkey oaks.

Fusiform rust lives from year to year in the living bark of pine branches and stems, causing galls that are typically spindle shaped. In March or early April powder-like yellow spores are produced on pine cankers and carried by the wind to young oak leaves. Most pine infection occurs in April during periods when temperatures are between 60° and 80° F. and the humidity close to the moisture saturation point for a minimum of 18 hours.

Rust spreads sufficiently far from oak to pine to preclude oak eradication as a practical control measure. Periodic artificial pruning of branches with galls less than 15 inches from the stem will prevent many trunk infections from developing. Trees with trunk cankers should be salvaged in thinning. The following rule covers the period of salvageability of trunk-cankered trees: (a) Less than 50 percent of circumference killed but no bend in stem at canker or sunken canker face—an even chance of salvage for 5 years, (b) 50 percent of circumference killed, with a bend at canker and either a normal or sunken canker face—less than even chance of salvage for 5 years.

Fomes Annosus Root Rot

Fomes annosus root rot is the number one disease problem of coniferous plantations in Europe. The causal fungus is also native to—and widely distributed in—the United States. It is most serious in thinned plantations.

Root rot is usually unnoticed until a tree dies. A year before death a pine may have thin foliage, short needles, and slight chlorosis, but these symptoms are not always present and often are inconspicuous. Beetles may attack dying trees, and care is needed to distinguish between root rot and insect kill. The fruiting bodies of *Fomes* frequently develop on or near trees which have been recently killed, either at their bases, on exposed roots, or in the surrounding duff. These conks are inconspicuous and usually hidden under the duff. Conks are irregular in shape, up to 3 inches across. Their upper surface is grayish-brown, either light or dark. The under surface is white to tan, and contains many minute pores.

Fruiting bodies often are present on or around live trees that are standing near infected stumps or recently killed trees. Infected roots first develop a resin-soaked appearance or pinkish to dull violet sapwood. Later, elongate white decay pockets develop in roots, leading to the final stringy white rot which is distinct from the usual brown rot in roots killed by most other causes.

Almost all attack originates with thinning. The spores, which may be present in the air, infect freshly cut stump surfaces. The fungus then spreads down the stump and out along the roots to infect adjacent trees whose roots touch or are grafted to those of the stump. Mortality may begin 2 or 3 years after the first thinning. Whenever pines die a few years after thinning, root rot should be suspected.

The British report good protection by copiously treating the stump with coal-tar creosote immediately after felling the tree. All exposed wood, including debarked areas, must be treated. The creosote prevents invasion by *F. annosus* but permits colonization of the stump by other fungi antagonistic to it.

Decay After Fire Injury

Of the diseases that afflict hardwoods, the most serious are caused by fungi that rot the heartwood. Heart rots are the chief cause of cull in southern hardwood stands, and about 90 percent of the rot enters the base of the trees through wounds caused by fire. Typically, rot reaches the heartwood about 4 years after a tree is wounded and thereafter works upward at rates varying with the species of tree and fungus.

Except for the first 10 years after wounding, the average rate of spread of established rot per decade is 2.0 feet for overcup oak and sugarberry, 1.6 feet for water hickory, 1.3 feet for red oaks, 1.3 feet for green ash, and 0.9 feet for sweetgum and elm.

The following rule of thumb can be used in deducting for butt rot: First reduce the merchantable length of the stem by the length of rot as indicated by hollow, butt, bulge, or rot diameter on the stump, and then reduce the d.b.h. measurement 1 inch for each 6 feet of rot.

Other Common Forest Pests

The blight dieback of sweetgum sometimes wipes out entire stands. Soil factors that contribute to a shortage of available water during periods of rainfall deficiency appear responsible. The first indication is a thinning of part of the crown. The thinning spreads, sometimes rapidly and sometimes slowly. If favorable moisture conditions return before deterioration has progressed too far, some trees will recover. Blight has been most severe during droughts and on sites considered least suited to sweetgum.

Oak wilt has not yet been found in the Project area. The fungus that causes the wilt will not survive in twigs longer than 3 days at temperatures of 95° F. or higher. This fact suggests that the wilt may never become serious this far south.

Borers and bark scarrers cause the greatest amount of insect damage to hardwoods, particularly the oaks. The holes, bark pockets, stains, and other blemishes caused by these insects do not destroy the wood, but greatly lower the value of the product by limiting the number and size of the defect-free pieces that can be cut from the log or lumber.

Rabbits frequently cut down one- and two-year-old pine seedlings without making any apparent effort to eat them. Application of 25 percent zinc dithiocarbamate-amine complex (3.2 percent metallic zinc) in a latex emulsion to the seedling tops while in nursery beds will reduce rabbit damage during the first year in the field to an acceptable amount.

Cotton rats will girdle pine seedlings planted in areas with heavy grass roughs. The U. S. Fish and Wildlife Service recommends broadcasting milomaize treated with strychnine to control rats.

Loblolly pine in north Mississippi has been damaged by ice and heavy snow. Terminals have been broken out and trees bent to the ground. The most serious damage has occurred in heavily cut young stands. Damage from ice can be minimized by making frequent, light thinnings.

ECONOMICS

Marketing

Ultimately each tree and each piece of tree should be directed into the product that will return the greatest profit. This will require log concentrating and sorting facilities in each county. Unfortunately such facilities are not yet in sight.

Markets for pine and hardwood sawlogs and for pine and gum pulpwood are locally available throughout the Project Area. Markets for veneer logs are located on the fringes of the area but are economically accessible when quality logs are available in truckload or carload lots. Markets for specialty species such as ash, dogwood, persimmon, cedar, cherry, hickory, and walnut, and white oak stave bolts are often only temporarily available due to the transient nature of the mills. Poles, piling, posts and ties are also products with sporadic markets. Rough merchantability specifications for most species are given in table 4. Recently

there has been an increase in demand for charcoal wood but the supply is so great that the effect of this demand will be highly localized.

The stumpage price for pine has been fairly well correlated with the wholesale value of No. 2 common pine lumber, averaging 41 percent with a low of 21 percent and a high of 61 percent. Stumpage prices are naturally dependent upon supply, demand, and quality. Alternative pulpwood and sawlog stumpage prices for loblolly pine are given in table 17 in the Appendix.

Since many small landowners cut and haul their own pulpwood detailed specifications follow. Sticks of pulpwood should be sound, green, and fairly straight. All knots and branches must be trimmed parallel and flush with the stick. Sticks must have square cut ends. Stick lengths for rail shipment cannot be more than 5′3″ and for truck haul 5′3″ to 5′6″. Minimum stick diameter is 3.5″ inside bark on the small end and maximum diameter 20″ inside bark at the large end. Any crooked or deformed stick which will not pass through a 20″ cylinder is considered to be in excess of 20″ and is unacceptable.

Sticks of wood in the following classes are undesirable and will be culled: small wood, sap rot, heart rot, hollow, charred, stumps, splintered, forked, and those containing metal.

Reduction of the top merchantability limit from 4 to 3 inches increases the volume extracted from 9-inch trees only 3.4 percent but the increase is over 10 percent from 6-inch trees and nearly 21 percent from 5-inch trees.

Taxes

Ad valorem taxes on forested land throughout most of the area run from $.20 to $.30 per acre plus 2 cents per acre for fire protection. Mississippi law provides for the exemption of all growing timber from the property tax and for the payment of a yield tax on forest products harvested. The purchaser, according to the 1956 law, must pay a tax of 40 cents per M board feet Doyle for pine and other softwood logs and 30 cents per M board feet for hardwood logs; 9 cents per standard cord of hardwood pulpwood and 12 cents per standard cord of pine pulpwood; 10 cents per ton of stumpwood and lighterwood; 12 cents per 400-pound barrel of turpentine; 1 percent of market or delivered price—rough or whitewood—for poles, piling, and posts; 30 cents per M board measure for crossties and lumber of all species and kind; and 30 cents per M feet for all other timber.

Many landowners pay a larger income tax on their woods operations than the law requires. Some do not deduct an allowance for depletion representing the owner's investment in the timber harvested. To find the depletion allowance, divide the amount of capital investment in the timber at time of harvest by the volume of timber present in the stand and multiply by the number of units sold or cut. If timber was damaged or destroyed during the year the landowner may be entitled to claim a deduction on his income tax return.

Many do not realize that receipt from sales of timber and forest products owned for longer than 6 months can be reported as a capital gain rather than as ordinary income resulting in a substantial tax reduction. In treating receipts as capital gains there are three situations which must be handled separately: standing timber sold on a lump-sum basis: standing timber sold on a pay-as-cut basis; and timber cut by the taxpayer, who sells the resulting product.

Operating expenses may be "expensed", that is deducted from gross income year by year. These expenses may include the cost of hired labor, hire of animals, trucks, tractors, or other equipment, purchase of tools of short life or small cost such as axes, saws, sledges, wedges, etc., cost of materials and supplies, incidental repairs, machine operating expenses, and management costs such as fees charged by a consulting forester (when not related to a timber sale), accountant, etc.

Capital expenditures are "capitalized", that is treated as an investment to be recovered through depletion in the case of timber or through depreciation in the case of equipment. Purchase of standing timber and of equipment having a useful life of more than 1 year, and expenditures for seeding or planting or for major equipment repairs must all be capitalized.

Where timberlands are not producing income, carrying charges and development expenditures may be either "expensed" or "capitalized" but a consistent policy from year to year must be followed. Carrying charges include annual taxes, interest payments, protection costs for fire or pest control, and insurance premiums. Development expenditures may include costs of girdling, pruning, and improvement cuttings but should be reduced by incidental amounts received for products sold.

It is to the landowners advantage to expense rather than capitalize costs if other income is sufficient to offset such expenditures. Where timberlands are producing income, costs such as those described in the paragraph above are regarded as operating costs and must be expensed. In any case, where income from timber sales is more than a few dollars it will pay to consult an accountant.

Table 4.—*Special merchantability specifications*

Product	Primary form	Minimum scaling diameter	Species
Veneers	Logs & bolts	24-30″ for slicing 16-18″ for turning	Sweetgum, maples, ash, pecan, sycamore, walnut, cherry, & all but water oaks
Face			
Commercial	Logs & bolts	12″, very rarely 10″	Yellow-poplar, sweetgum, tupelos, cottonwood, sycamore, & occasionally maples, oaks (except water oaks), ash, soft elm, & magnolia
Package	Logs & bolts	12″ occasionally	Most soft-textured species, but especially sweetgum, the tupelos, yellow-poplar, cottonwood, sycamore & soft elm
Cooperate			
Tight	Bolts	14″	White oaks.
Slack	Bolts & logs	12″, occasionally 10″	Principally sweetgum, soft elm, hackberry, & sycamore
Lumber			
Factory	Logs	12″; 10″ for certain species	Principally oaks, sweetgum, tupelos, & ash but all species are taken
Structural	Hdwd. logs	Generally 10″ 7″ may take 6″	Mostly oaks & gums Pine & cypress
Shipping container	Logs & bolts	8-10″	Soft-textured hwds. preferred
Local use	Logs	8″	Anything straight & sound
Dimension stock & specialties	Bolts	Generally 10″ Persimmon 8″	All staple species for furniture oaks, hickories, ash, dogwood, & persimmon for handles, vehicle, & implement parts, athletic goods, spindles
Poles	Piece	5″	Pine
Piling	Piece	5 to 8″	Pine & baldcypress Most hard or tough, firm species for either subsurface or temporary use
Posts	Piece	2½″ 3″	Pine White oaks, mulberry, baldcypress, sassafras
Ties	Piece		Oak, gum
Cordwood			
Pulpwood		3½″ 4″	Pine Sweetgum, tupelos, Cottonwood, willow
Chemical wood		4″ diameters 7″ & larger must be split	Oaks, hickories
Fuelwood		2″	Oaks, hickories, ash

[1]Adapted from Management & Inventory of Southern Hardwoods, Agriculture Handbook No. 181, USDA

The Tennessee Pulp and Paper Company mill at Counce, Tennessee, offers a nearby market for pulpwood from the Project.

Fully stocked stands of pine will provide a solid backlog for the local economy.

MULTIPLE-USE CONSIDERATIONS

Wildlife

Good forest and wildlife management can go hand-in-hand. It is important to stress this to landowners and to emphasize that wildlife populations, regardless of the perfection of habitat, cannot be maintained in satisfactory numbers in the face of illegal kill. Where pine is to be the preferred species, wildlife should be given consideration in the stream bottoms and on other sites such as lower slopes, draws, and the deep Brown Loam bluffs where hardwoods of value can be produced. If this concept is acknowledged there will be little conflict between forest and wildlife management programs. Deer, squirrel, quail, and ducks can be provided for in our management practices.

A deer is a ruminant whose diet is chiefly vegetable materials, consisting of browse, a wide assortment of herbaceous foodstuffs, and certain fruit when available. Vegetable material and browse supply the bulk of the food consumed. Herbaceous materials include greenbrier, redbay, honeysuckle and herbs during spring and summer. Oak mast is a winter staple in years of abundance, supplemented by browse of leaves, buds, twigs and bark. Winter diets can be improved where needed by planting annual rye grass or fescue on forest roadways and firebreaks.

A program of frequent cuttings, systematically applied, is a good guarantee of a satisfactory and reasonably stable deer habitat. Removal of undesirable hardwoods from pine stands may adversely affect the food supply on the particular area treated. In most cases, however, management for quality hardwoods in the stream valleys and river bottoms interspersed throughout the pine type will offset the loss of poor quality hardwoods on slopes and ridges.

Gray squirrels prefer vast acreages of hardwoods, either on the uplands or on bottomlands adjacent to the larger rivers. Fox squirrels, on the other hand, prefer a mixture of pine and hardwoods. The preferred food of squirrels is mast of hickory, white oaks, and to a lesser extent, black oaks, beech, and pine. They also feed on berries and other fleshy fruit during the season when such fruits are available. Modern management for quality hardwoods favors squirrels.

In addition to food, a basic habitat requirement for squirrel is the presence of den trees. A suitable den tree is one of the hardwoods, preferably oak, blackgum, or beech, at least 15 inches in diameter breast high. It should have a good, thrifty crown and a small hole such as might be made by a broken limb hollowed out by woodpeckers. Large cavities in the bole are not suitable for squirrel dens, as they afford entrance for competitor animals such as opossum and raccoon. To maintain a shootable squirrel population, there should be two or more den trees per acre, and additionally, three or four food trees such as oak or hickory.

Based on average acorn and nut yields of food producing trees and food requirements of squirrels, it has been estimated that from 7 to 15 oak trees over 15 inches in diameter breast high will provide sufficient mast to carry one squirrel from September through April. Squirrels seldom move great distances, more generally within a mile, which would indicate that if the required food and den trees were within a mile radius, minimum mast requirements would be satisfied.

Project policy will be to recommend the leaving of at least two game food trees per acre where available, with not more than 100 yards between neighbors. Where there are insufficient commercially valuable trees, leave enough oak and small hickories. Six den trees per forty, with not more than half-a-quarter between neighbors should be left. If the den tree is also a game food tree, so much the better. Wolf trees should not be left. Occasional thickets of hawthorn and huckleberry are desirable. Wildlife requirements can generally be met by leaving ribbons of hardwoods in minor stream bottoms and moist draws and by leaving old house place trees.

Quail, although normally a bird of agricultural areas, will thrive on cutover pinelands and under a canopy of forest trees provided the overstory is not too dense. Pine forests or a mixture of pine and hardwoods are most suitable. Opening up the understory by deadening dense stands of scrub hardwoods favors quail. Young plantations of pine prior to closing of their canopy are good habitat.

During the summer and fall, fruits and animal matter (mostly insects) form a staple part of the diet. When these foods are no longer available in abundance, seeds become important in the diet and continue to be throughout the dormant seasons and the period of early vegetative growth in the spring. Seeding of roadbanks, logging roads, and power line rights-of-ways will not only provide food but also excellent cover for quail.

Owners of bottomland hardwood forests can manage their holdings for ducks as well as timber production by establishing green tree reservoirs during the dormant season. Three factors govern the success of this practice; first, ample waterfowl food as found in a forest stand containing acorn bearing oaks such as water oak, willow oak, Nuttall oak and cherrybark oak; second, a water supply which can be controlled; and third, provisions for draining the water off the land prior to tree growth. Water depths of 1 foot to 18 inches are considered optimum for waterfowl feeding. The ground does not need to be completely flooded; narrow ridges, often supporting the desirable oaks, may remain dry and still be utilized by ducks.

Flooding, controlled by levees, can be accomplished by the retention of rainfall or of floodwaters, diversion of inflowing streams, and pumping. Green tree reservoirs can be flooded from early November to late February, including 10-day periods at the beginning and end for flooding and draining. Management practices such as the removal of culls and undesirable trees benefit the ducks by stimulating mast production of the residual stands.

Practices harmful to wildlife are uncontrolled burning, excessive grazing, clear-cutting of large areas, and cutting out of all den and food trees.

Although there is generally little conflict between wildlife and good forest management, over-populations of deer will severely browse hardwood reproduction. Rabbits feed on the bark of hardwood seedlings, new growth of a variety of species, and cut down many pine seedlings. Beavers are increasing in many localities and sometimes have caused the death of substantial acreages of timber through the flooding caused by their dams.

Recreation

Recreational values include the aesthetic values and on-the-ground recreational uses such as for camping, hiking, nature study, riding, picnicking, hunting, fishing, mineral, leaf, twig, and insect collection, and general escape from urban tensions.

There is increasing pressure on forest lands for these purposes. Landowners should be encouraged to develop recreational facilities such as camp and picnic grounds, roadside zones, and scenic areas for their own enjoyment and to foster good public relations.

It is particularly important to preserve scenic values along all well traveled roads. Dead, dying, and defective trees within 100 feet of the road centerline should be felled and the tops of these and those cut for sawlogs lopped. Dogwood, redbud, and other flowering trees and shrubs within this roadside strip should be preserved. Timber marking in this zone should be aimed at improving aesthetics.

Construction of spring and stream-fed ponds should be encouraged to serve as wildlife and fire water holes, fishing spots, and camping and picnic areas. Measures should be taken to avoid erosion and stream pollution in these areas. Firebreaks are desirable around areas where recreational use is heavy.

Grazing

Overgrazing of woodlands in north Mississippi is generally detrimental to the production of forest crops. It can result in damage to watershed values, soil compaction, increased runoff, reduction in site quality, damage to reproduction, deterioration of stand composition, reduction in wildlife habitat, loss of soil, and deterioration of soil physical properties.

Farm woodlands even when wisely managed seldom produce appreciable quantities of forage for extended periods and forage quality is low throughout much of the year. Attainment of forest management goals will further decrease the forage resource. Returns from woodland grazing are low and the harmful effects normally exceed the benefits.

Pasturing and tree growing cannot be profitably combined on the same area and in hardwood stands will preclude effective sustained-yield management. Grazing animals browse on young trees preferring some of the best species such as ash, oak, and yellow-poplar. Fortunately sweetgum is a less palatable species. Trees not completely killed by grazing are set back and malformed.

Healthy watersheds provide outdoor recreation.

Grazing animals injure exposed roots at the base of the trees permitting insects and disease to enter. Grazing also packs the soil, reduces the leaf litter, and lowers the rate of moisture absorption. A Wisconsin study showed that grazing increased water runoff on sloping woodland from 197 gallons per acre to 9,308 gallons during one year. In west Tennessee the upper 3 inches of soil in a pasture was approximately three times as compact as under an adjacent hardwood stand and 55 percent more compact than under two neighboring pine plantations. Lower soil moisture results in slower tree growth.

Hogs are not as hard on the forest as cattle but in heavy concentrations will eat all the mast, particularly that of the better white oaks. Hogs compete with wildlife for mast and cattle deprive the deer of the browse needed to tide them through the winter.

MENSURATIONAL AIDS

Cruising and Sampling Techniques

Point sampling with a prism or angle gage with a basal area factor of 10 will give an approximate estimate of the stand volume and basal area and the general condition of the stand—factors pertinent to the initiation of management. Generally 25 sample points systematically distributed over the area will suffice. Approximate sampling errors as a percent of volume and with respect to the number of points sampled follow:

Points *No.*	*Error* *Pct.*
25	23
50	17
100	12
200	8
400	6
1600	3

Suggested tally sheets for this type of inventory are shown in Figures 1 and 2 in the Appendix. The pulpwood tally sheet can be clipped to the inside of the Tatum board cover; the sawtimber sheet in the conventional fashion. The number of 16-foot sawlogs in each sampled tree is tallied to the nearest half-log according to species group and condition class. Pulpwood sized trees are tallied to the nearest merchantable 10-foot length. Cull trees are recorded by dot tally. The tally is kept separately by individual points in order to provide some idea as to how the timber is distributed and the percent of the area needing cull timber removal.

Reproduction—saplings 1-4 inches d.b.h. and seedlings 6 inches tall to 0.51 inches d.b.h.—should be tallied on a circular 2-mil-acre plot (radius 5.266′) at the center of each point sample. If all 2 mil-acre plots are stocked with desirable reproduction the future stand will consist of 500 trees spaced approximately 9.3 feet apart. By placing an asterisk alongside of the reproduction plots needing release an estimate of the intensive timber stand improvement work required can be obtained.

Conversion factors for use with these tally sheets are as follows:

For a given tree class, basal area per acre (square feet) is estimated by *tree count,* multiplied by the instrument *BA factor,* and divided by the *number of sample points* in the record-unit.

For a given tree class, rough cords per acre (128 cubic feet of wood, air, and bark) is estimated by *total height sum,* multiplied by *.005 times instrument BA factor,* and divided by the *number of sample points* in the record-unit.

For a given tree class, gross board feet per acre (Int. ¼-inch rule) is estimated by merchantable *height sum,* multiplied by *60 times* the instrument BA factor, and divided by the *number of sample points* in the record-unit.

Doyle volumes can be obtained by estimating the average tree size and then multiplying by the corresponding ratio appearing below:

Average DBH Inches	*Pine*	*Upland hardwood*	*Bottomland hardwood*
	----Ratio Doyle International----		
12	.48	—	—
14	.59	.60	—
16	.66	.66	.62
18	.72	.72	.68
20	.78	.77	.74
22	.82	.81	.78
24	.85	.84	.81

Repeated periodic inventories of permanent point-samples can be made to determine growth. Where individual tree records are maintained for numbered trees the next future reexamination will number and record newly qualifying trees, though they will not enter into the calculations for the preceding periodic growth. Calculation of each subsequent periodic growth, however, will always use all trees tallied at the preceding examination, and basal areas at the start of each new period will be used in subsequent weighting. If individual trees are not numbered and subsequently identifiable each re-tally at a point would include all newly qualified trees, and basal area at the time of tally should be used in weighting, just as in ordinary cruising.

On permanent point samples questionable trees should be checked by measuring out from the point sample center with a tape to the tree center. To qualify as a sample tree, distance from heart of tree to sampling point (in feet) must be less than tree d.b.h. (in inches) times plot radius factor (2.75 for a 3-diopter prism). Each 3.3 inches of plot radius encompasses another tenth-inch of tree diameter. It is not necessary to correct for slope if the slope is less than 10 percent. When the slope is greater than 10 percent the easiest way to correct for slope is to hold the plane of the prism perpendicular to the slope at all times.

Marking Inventory

When trees are marked for sale and the volume will be less than 500,000 board feet, each marked tree should be tallied by diameter and merchantable height to the nearest half-log. In larger sales every tenth tree can be tallied. When marking pulpwood tree diameter and merchantable height to the nearest 10 feet of at least 200 trees should be recorded. When the marking crew is large enough to include a full time tally man, recording the diameter and height of every tree is advised. A sample tally sheet is shown in Figure 3 in the Appendix.

Volume, Log, and Basal Area Tables

Holly Springs National Forest (Int. ¼-inch rule) volume tables for upland hardwood and pine are given in tables 10 and 11 in the Appendix. Local volume tables are preferable but these tables are conservative and should be satisfactory for use throughout the north Mississippi uplands.

Pine pulpwood volume tables, adapted from those of Mesavage, are given in tables 12, 13, and 14 in the Appendix. These tables are based upon form class measurements of 802 loblolly pine, 680 shortleaf pine, and 93 slash pine growing in 16- to 26-year-old plantations. Since form class is dependent upon age, site, species, tree size, and whether or not the stand has been thinned to remove the trees of poorer form it was necessary to prepare three tables. Second-growth pines often have a higher form class than plantation grown trees. Form class measurements on a minimum of 5 trees per d.b.h. class (preferably ten) should be taken before selecting a table.

Scaling

Form class values used in constructing the three tables were:

DBH In.	*Table 12 Pct.*	*Table 13 Pct.*	*Table 14 Pct.*
5	57	57	62
6	62	62	67
7	62	67	67
8	67	67	72
9	72	72	72
10	67	72	72
11	62	72	77
12	—	—	77

Scale of 16-foot logs to the nearest board foot is given in table 15 in the Appendix for the three most commonly used rules. Lumber mill tally should most closely approximate the International ¼-inch values. Logs sold on the Doyle rule should bring a higher price per thousand than under the other rules in order to compensate for the lower scale.

When fixed area plots are used in cruising or for growth determinations, basal area per acre can be easily determined using the values given in table 16 in the Appendix.

Surveying

Marking

Measuring

Checking growth

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APPENDIX

Figure 1.—*Sawtimber point sampling tally*
Tally No. of 16-foot logs to half logs in pines 10″ & larger, hdwds. 13″ & larger

Point No.	Species group														
	Cut	Leave	Cull	Cut	Leave	Cull	Cut	Leave	Cull	Cut	Leave	Cull	Cut	Leave	Cull
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
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18															
19															
20															
21															
22															
23															
24															
25															

	Total	Cut	Leave	Cull	Per acre	Cut	Leave	Cull
logs								
trees								
Tree count								
Bd. ft.								
Sq. ft.								

Figure 2.—*Pulpwood point sampling tally*
Tally trees 5" d.b.h. & larger to nearest 10 feet

Point No.	Species group												Reproduction 2 mil-acre					
	Cut	Leave	Cull	Cut	Leave	Cull	Cut	Leave	Cull	Cut	Leave	Cull	Pine		Desirable hdwd.		Undesirable hdwd.	
													Seed.	Sap.	Seed.	Sap.	Seed.	Sap.
1																		
2																		
3																		
4																		
5																		
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25																		

Trees Hts.	Total	Cut	Leave	Cull	Per acre	Cut	Leave	Cull	Number per acre
Tree count									stocking
Cords									
Sq. ft.									Star reproduction plots needing release

Figure 3.—*Inventory of trees marked for sale*

DBH	Pine					Oak[1]					Soft hardwoods[1]				
	10'	20'	30'	40'	50'	10'	20'	30'	40'	50'	10'	20'	30'	40'	50'
5															
6															
7															
8															
9															
10															
11															
12															
Total trees															
	1 log	1½ logs	2 logs	2½ logs	3 logs	1 log	1½ logs	2 logs	2½ logs	3 logs	1 log	1½ logs	2 logs	2½ logs	3 logs
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
Total trees															

[1]Minimum sawlog sized tree is 13" d.b.h.

Table 5.—*Commercial forest area by site and forest type (1957)*

Forest type	Site					
	Ridge & upper slope	Upland flat	Slope	Minor bottom, terrace, branch head	Major bottom, and terrace	Total
	Thousand acres					
Loblolly-shortleaf pine	220.3	97.6	85.4	39.5	..	442.8
Oak-pine	199.2	59.9	99.0	58.2	..	416.3
Oak-hickory	353.3	124.4	209.0	204.5	23.9	915.1
Bottomland hardwood	..	..	..	54.9	166.0	220.9
Total	772.8	281.9	393.4	357.1	189.9	1995.1

Table 6.—*Commercial forest area by major forest type and stand size (1957)*

Forest type	Stand size				
	Large sawtimber	Small sawtimber	Pole timber	Seedling and sapling	Nonstocked and other
	Thousand acres				
Loblolly-shortleaf pine	5.9	97.5	111.5	223.1	4.8
Oak-pine	5.4	27.8	131.0	244.2	7.9
Oak-hickory	54.4	94.4	328.6	392.1	45.6
Bottomland hardwood	28.5	37.0	75.3	71.1	9.0
Total	94.2	256.7	646.4	930.5	67.3

Table 7.—*Commercial forest area by degree of stocking and forest type (1957)*

Forest type	Degree of stocking			
	Well stocked	Medium stocked	Poorly stocked	Non-stocked
	Thousand acres			
Loblolly-shortleaf pine	242.1	155.0	40.9	4.8
Oak-pine	129.5	163.6	115.4	7.8
Oak-hickory	377.8	276.1	220.1	41.1
Bottomland hardwood	105.1	63.6	50.3	1.9
Total	854.5	658.3	426.7	55.6

Table 8.—*Sawtimber and cubic volume per acre by forest type (1957)*

Forest type	Species group	Volume			
		Sawtimber volume		Cubic volume	
		Area	Acre	Area	Acre
		Million bd. ft.	*Bd. ft.*	*Million cu. ft.*	*Cu. ft.*
Loblolly-shortleaf pine	Softwood	452.9	1023	125.3	283
	Hardwood	86.7	196	30.4	69
Oak-pine	Softwood	135.9	326	52.8	127
	Hardwood	146.9	353	56.1	135
Oak-hickory	Softwood	27.1	30	10.9	12
	Hardwood	905.3	989	309.1	338
Bottomland hardwood	Softwood	10.8	49	3.2	14
	Hardwood	373.8	1692	122.2	553
All types	Softwood	626.7	314	192.2	96
	Hardwood	1512.7	758	517.8	260

Table 9.—*Area of sawtimber stands by stand quality and forest type (1957)*

Forest type	Stand quality		
	All qualities	Fair or better	Poor
	Thousand acres		
	103.4	49.1	54.3
Loblolly-shortleaf pine	33.2	7.3	25.9
Oak-pine	144.8	55.0	93.8
Oak-hickory	65.5	32.1	33.4
Bottomland hardwood	—	—	—
All types	350.9	143.5	207.4

Tables 5-6-7-8-9 are taken from the Forest Survey of 1957 and were prepared for the area within the Yazoo-Little Tallahatchie Flood Prevention Project.

Table 10.—*Holly Springs International 1/4" Rule Net Volume Table for Pine (Adapted from Scribner table)*

	FC 74	FC 77	FC 80	FC 83	FC 84	FC 85	FC 85
	Number of logs						
DBH	1	1½	2	2½	3	3½	4
8	18						
9	25						
10	32	46	63	78	91		
11	41	58	80	102	118		
12	50	71	98	125	145	162	173
13	60	87	120	152	178	199	214
14	71	103	141	178	212	236	254
15	82	120	166	211	249	280	304
16	93	138	190	244	286	326	355
17	107	159	219	280	332	377	412
18	121	180	248	316	377	428	468
19	137	204	281	360	428	486	531
20	153	226	314	403	479	543	594
21	170	252	350	452	537	608	667
22	188	278	387	501	595	674	740
23	208	308	428	553	660	746	818
24	227	338	469	604	724	818	895
25	246	370	514	664	790	899	986
26	266	400	558	722	855	979	1076
27	288	437	606	782	932	1066	1172
28	311	472	654	843	1010	1154	1267

Table 11.—*Holly Springs International 1/4" Rule Net Volume Table for Hardwood (Adapted from Scribner table)*

DBH	FC 77	FC 78	FC 78	FC 79	FC 79
	Number of logs				
	1	1½	2	2½	3
12	42	64			
13	55	79	100		
14	68	94	120	147	167
15	81	113	143	172	197
16	92	130	166	199	229
17	107	151	190	231	266
18	122	169	217	262	302
19	138	194	246	298	344
20	153	218	275	338	389
21	169	244	309	375	436
22	187	270	342	419	483
23	208	296	380	464	537
24	229	322	414	510	590
25	248	346	455	556	644
26	271	388	496	603	698
27	295	420	537	657	763

Table 12.—*Merchantable rough cord volume* [1]

DBH	Merchantable length of stem (feet)										
	10	15	20	25	30	35	40	45	50	55	60
	Pulpwood volume (rough cords)										
5	.012	.016									
6	.016	.021	.028	.032	.036						
7		.027	.038	.043	.047	.052					
8			.048	.056	.063	.070	.078	.086	.093		
9			.067	.078	.088	.099	.109	.120	.131	.142	.152
10			.071	.082	.092	.103	.113	.125	.135	.146	.156
11					.113	.122	.131	.140	.148	.157	.166

[1] Use for shortleaf pine on sites of less than 60, or when younger than 20 years, or if never thinned.

Table 13.—*Merchantable rough cord volume* [1]

DBH	Merchantable length of stem (feet)										
	20	15	20	25	30	35	40	45	50	55	60
	Pulpwood volume (rough cords)										
5	.012	.016									
6	.016	.021	.028	.032	.036						
7			.037	.043	.049	.055	.061				
8			.048	.055	.063	.071	.079	.086	.093		
9			.067	.079	.088	.099	.109	.120	.131	.142	.152
10			.080	.093	.105	.117	.129	.141	.154	.166	.179
11					.121	.135	.149	.163	.177	.192	.206

[1] Use for shortleaf on sites of 60 or better, or when 20 years and older, or for younger stands that have been previously thinned. Use for loblolly pine on sites of less than 70, or when younger than 20 years or if never thinned.

Table 14.—*Merchantable rough cord volume* [1]

DBH	Merchantable length of stem (feet)										
	10	15	20	25	30	35	40	45	50	55	60
	Pulpwood volume (rough cords)										
5	.012	.016	.019								
6		.023	.028	.033	.037	.041	.046	.052			
7			.037	.043	.049	.055	.061	.068			
8			.055	.064	.073	.081	.029	.099	.108		
9			.067	.079	.088	.099	.109	.120	.131	.142	.152
10			.080	.093	.105	.117	.129	.141	.154	.166	.179
11					.134	.146	.158	.170	.182	.194	.206
12					.156	.170	.184	.197	.211	.224	.238

[1] Use for slash pine. Use for loblolly on sites of 70 or better, or when 20 years or older, or for younger stands that have been previously thinned.

Table 15.—*Scale of 16-foot logs to nearest board foot*

DIB	Log Rule		
	International ¼ in.	Scribner	Doyle
Inches	*Board feet*		
6	19	12	4
7	28	21	9
8	39	30	16
9	51	42	25
10	65	55	36
11	80	70	49
12	97	86	64
13	115	104	81
14	136	123	100
15	157	144	121
16	181	166	144
17	205	189	169
18	232	216	196
19	260	243	225
20	290	272	256
21	321	302	289
22	354	334	324
23	388	368	361
24	424	403	400
25	462	440	441
26	501	478	484
27	542	518	529
28	584	559	576
29	628	602	625
30	674	647	676

Table 16.—*Area of Circles in Square Feet*
(Basal area table)

Diameter	Diameter—tenths of inches										Diameter
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Inches	*Area—square feet*										*Inches*
						0.001	0.002	0.003	0.003	0.004	
1	0.005	0.007	0.008	0.009	0.011	0.012	0.014	0.016	0.018	0.020	1
2	.022	.024	.026	.029	.031	.034	.037	.040	.043	.046	2
3	.049	.052	.056	.059	.063	.067	.071	.075	.079	.083	3
4	.087	.092	.096	.101	.106	.110	.115	.120	.126	.131	4
5	.136	.142	.147	.153	.159	.165	.171	.177	.183	.190	5
6	.196	.203	.210	.216	.223	.230	.238	.245	.252	.260	6
7	.267	.275	.283	.291	.299	.307	.315	.323	.332	.340	7
8	.349	.358	.367	.376	.385	.394	.403	.413	.422	.432	8
9	.442	.452	.462	.472	.482	.492	.503	.513	.524	.535	9
10	.545	.556	.567	.579	.590	.601	.613	.624	.636	.648	10
11	.660	.672	.684	.696	.709	.721	.734	.747	.759	.772	11
12	.785	.799	.812	.825	.839	.852	.866	.880	.894	.908	12
13	.922	.936	.950	.965	.979	.994	1.009	1.024	1.039	1.054	13
14	1.069	1.084	1.100	1.115	1.131	1.147	1.163	1.179	1.195	1.211	14
15	1.227	1.244	1.260	1.277	1.294	1.310	1.327	1.344	1.362	1.379	15
16	1.396	1.414	1.431	1.449	1.467	1.485	1.503	1.521	1.539	1.558	16
17	1.576	1.595	1.614	1.632	1.651	1.670	1.689	1.709	1.728	1.748	17
18	1.767	1.787	1.807	1.827	1.847	1.867	1.887	1.907	1.928	1.948	18
19	1.969	1.990	2.011	2.032	2.053	2.074	2.095	2.117	2.138	2.160	19
20	2.182	2.204	2.226	2.248	2.270	2.292	2.315	2.337	2.360	2.382	20
21	2.405	2.428	2.451	2.474	2.498	2.521	2.545	2.568	2.592	2.616	21
22	2.640	2.664	2.688	2.712	2.737	2.761	2.786	2.810	2.835	2.860	22
23	2.885	2.910	2.936	2.961	2.986	3.012	3.038	3.064	3.089	3.115	23
24	3.142	3.168	3.194	3.221	3.247	3.274	3.301	3.328	3.355	3.382	24

Diameter	Area	Diameter	Area	Diameter	Area	Diameter	Area	Diameter	Area
Inches	*Sq. ft.*	*Inches*	*Sq. ft.*	*Inches*	*Sq. ft.*	*Inches*	*Sq. ft.*	*Inches*	*Sq. ft.*
25	3.409	32	5.585	39	8.296	46	11.541	53	15.321
26	3.687	33	5.940	40	8.727	47	12.048	54	15.904
27	3.976	34	6.305	41	9.168	48	12.566	55	16.499
28	4.276	35	6.681	42	9.621	49	13.095	56	17.104
29	4.587	36	7.069	43	10.085	50	13.635	57	17.721
30	4.909	37	7.467	44	10.559	51	14.186	58	18.348
31	5.241	38	7.876	45	11.045	52	14.748	59	18.986

Revised & checked with Basal Area Table, "Forest Mensuration," by H. H. Chapman. M.C.R. 7-28-31

Table 17.—*Alternative pulpwood and sawlog stumpage prices for loblolly pine*

DBH	Cords per M Bd. ft.	Dollars per cord					
		2	3	4	5	6	7
				International 1/4" Rule			
8	4.0	$ 8.00	$12.00	$16.00	$20.00	$24.00	$28.00
9	3.7	7.40	11.10	14.80	18.50	22.20	25.90
10	3.4	6.80	10.20	13.60	17.00	20.40	23.80
11	3.2	6.40	9.60	12.80	16.00	19.20	22.40
12	2.9	5.80	8.70	11.60	14.50	17.40	20.30
13	2.7	5.40	8.10	10.80	13.50	16.20	18.90
14	2.5	5.00	7.50	10.00	12.50	15.00	17.50
				Scribner Rule			
8	4.4	8.80	13.20	17.60	22.00	26.40	30.80
9	4.1	8.20	12.30	16.40	20.50	24.60	28.70
10	3.8	7.60	11.40	15.20	19.00	22.80	26.60
11	3.6	7.20	10.80	14.40	18.00	21.60	25.20
12	3.4	6.80	10.20	13.60	17.00	20.40	23.80
13	3.2	6.40	9.60	12.80	16.00	19.20	22.40
14	3.0	6.00	9.00	12.00	15.00	18.00	21.00
				Doyle Rule			
8	6.8	13.60	20.40	27.20	34.00	40.80	47.60
9	6.8	13.60	20.40	27.20	34.00	40.80	47.60
10	6.8	13.60	20.40	27.20	34.00	40.80	47.60
11	6.3	12.60	18.90	25.20	31.50	37.80	44.10
12	6.2	12.40	18.60	24.80	31.00	37.20	43.40
13	5.2	10.40	15.60	20.80	26.00	31.20	36.40
14	4.5	9.00	13.50	18.00	22.50	27.00	31.50

[1] Adapted from Loblolly Pine by W. G. Wahlenberg.

FORM FOR TIMBER SALE AGREEMENT

_____, of_____
(I or we) (Name of purchaser) (Post office) (State)

hereinafter called the purchaser, agree to purchase from_____
(Seller's name)

of_____, _____, hereinafter called the seller, the designated trees from
(Post office) (State)

the area described below.

I. Description of sale area: Township_____, Range_____, Station_____.

II. Trees designated for cutting:
All trees marked by the seller, or his agent, with paint spots below stump height and at breast height.

III. The purchaser agrees to the following:

1. To pay the seller the sum of $_____.

2. To waive all claim to the above-described trees unless they are cut and removed on or before_____.
(Date)

3. To pay the seller for undesignated trees cut or injured through carelessness at the rate of $_____ each for trees measuring 10 to _____ inches in diameter and $_____each for trees_____ inches or over in diameter, at stump height.

4. To repair damage caused by logging to ditches, fences, bridges, roads, trails, or other improvements damaged beyond ordinary wear and tear.

5. Not to assign this agreement in whole or in part without the written consent of the seller.

IV. The seller agrees to the following:

1. To guarantee title to the forest products covered by this agreement and to defend it against all claims at his expense.

2. To grant the freedom of entry and right-of-way to the purchaser and his employees on and across the area covered by this agreement and also other privileges usually extended to purchasers of stumpage which are not specifically covered, provided they do not conflict with specific provisions of this agreement.

Signed in duplicate this_____day of_____ 19____

_____ _____
(Witness) (Purchaser)

_____ _____
(Witness) (Seller)

_____
(Witness)

_____
(Witness)